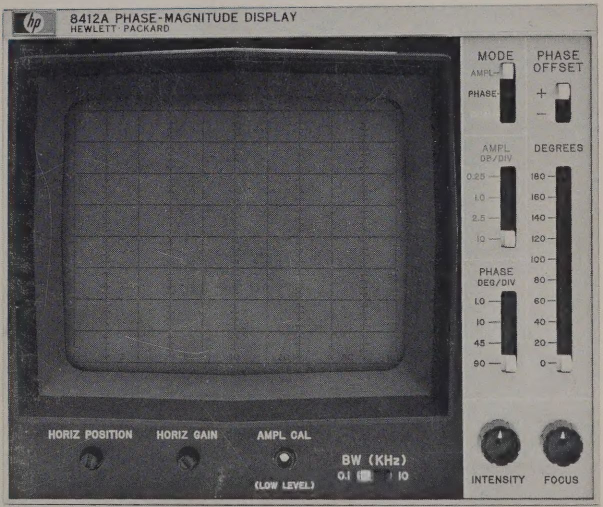
HP 8412A

OPERATING AND SERVICE MANUAL

PHASE-MAGNITUDE DISPLAY

8412A



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HP 8412A

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

MANUAL CHANGES

MANUAL IDENTIFICATION

Model Number: 8412A
Date Printed: April 1972
Part Number: 08412-90018

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes
1321A	1
1327A01606 thru 1327A02060	1, 2
1327A02061 thru 1327A02410	1, 2, 3

Serial Prefix or Number	Make Manual Changes
1531A	1, 2, 3, 4
1616A	1, 2, 3, 4, 5
1618A	1, 2, 3, 4, 5, 6
►1625A	1, 2, 3, 4, 5, 6, 7

► NEW ITEM

ERRATA

Inside front cover:

Insert new information regarding SAFETY, CERTIFICATION, and WARRANTY AND ASSISTANCE immediately inside front cover of manual (new information sheet supplied in this Manual Changes Supplement).

Page 1-1, General Information:

Add the following information preceding Paragraph 1-1:

1-A. SAFETY CONSIDERATION

General

This instrument has been designed and tested according to IEC Publication 348, "Safety Requirements for Electronic Measuring Apparatus," and has been supplied in safe condition. This is a Safety Class I instrument.

Service

Although the instrument has been designed in accordance with international safety standards, the information, cautions, and warnings in this manual must be followed to ensure safe operation and to keep the instrument safe. Service and adjustments should be performed only by qualified service personnel.

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

25 JUNE 1976
5 Pages

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Printed in U.S.A.

ERRATA (Cont'd)

Adjustment or repair of the opened instrument with the ac power connected should be avoided as much as possible and, when inevitable, should be performed only by a skilled person who knows the hazard involved.

Capacitors inside the instrument may still be charged even though the instrument has been disconnected from its source of supply.

Make sure only fuses of the required current rating and type (normal blow, time delay, etc.) are used for replacement. Do not use repaired fuses or short circuit the fuse holders.

Whenever it is likely that the protection has been impaired, make the instrument inoperative and secure it against any unintended operation.

WARNING

Servicing this instrument often requires that you work with the instrument's protective covers removed and with ac power connected. Be very careful; the energy at many points in the instrument may, if contacted, cause personal injury.

Page 6-3, Table 6-2:
Delete A1 08412-60030.
Delete A2 08412-60031.

Page 6-5, Table 6-2:
Delete A3 08412-60032.
Change A3C7 to HP Part No. 0160-2055, C:FXD CER 0.01 μF +80 −20% VDCW, Mfr Code 56289, Mfr Part No. C023F10F103ZS22-CD.

Page 6-6, Table 6-2:
Add "(Does not include A4A1)" after description for A4.
Delete REBUILT-EXCHANGE ASSEMBLY for A4.
Add "(Does not include A4)" after descriptions for A4A1.
Delete A4A1 08412-60045.
Delete A5 08412-60034.

Page 6-7, Table 6-2:
Change A5R2 to HP Part No. 0757-0466, R:FXD MET FLM 110K OHM 1% 1/8W, Mfr Code 28480, Mfr Part No. 0757-0466.
Delete second A5R2 under Reference Designation.
Delete FACTORY SELECTED PART under Description for A5A2.
Change A5R3 to HP Part No. 0757-0441; R:FXD MET FLM 8.25K OHM 1% 1/8W, Mfr Code 28480, Mfr Part No. 0757-0441.
Delete A6 08412-60035.
Delete A7 08412-60036.

Page 6-8, Table 6-2:
Delete A8 08412-60037.
Delete A9 08412-60038.

Page 6-10, Table 6-2:
Delete A10 08412-60039.

Page 6-11, Table 6-2:
Change V1 to HP Part No. 5083-1874

ERRATA (Cont'd)

Page 6-12, Table 6-2:
Change item 2 to HP Part No. 10178A.
Add 7120-4162 Label, Info.

Page 7-15, Figure 7-16:
Change A10R1 to A10R3, 12.1K.
Change A10R3 to A10R1, 8.25K.
Change A10R6 to A10R42.
Change A10R42 to A10R6.
Change A10R10 to A10R11, 12.1K.
Change A10R11 to A10R10, 8.25K.

CHANGE 1

Page 6-7, Table 6-2:
Add A5R42, HP Part No. 0698-0083, R:FXD MET FLM 1.96K 1% 1/8W, Mfr Code 28480, Mfr Part No. 0698-0083.

Page 7-21, Figure 7-22:
Add A5R42, 1960 Ohms from collector of A5Q10 to ground.

CHANGE 2

Page 6-12, Table 6-2:
Change first item 12 (under "Reference Designation") to HP Part No. 08412-00030.
Change second item 12 to HP Part No. 08412-00029.
Change first item 23 to HP Part No. 5000-9140.
Change second item 23 to HP Part No. 5000-3339.

CHANGE 3

Page 6-7, Table 6-2:
Change A5R1 to HP Part No. 0757-0464 R: FXD MET FLM 90.9K OHM 1% 1/8W.
Change A5R3* to HP Part No. 0757-0442 R: FXD MET FLM 10.00 K OHM 1% 1/8W.
Change A5CR4 to HP Part No. 1901-0033 DIODE: SILICON, 100 MA, 180 WV.

Page 7-21, Figure 7-22 (Schematic Diagram):
Change R1 to 90.9K.
Change R3 to R3* 10K.
Change CR4 to standard diode and delete 11.5V.

CHANGE 4

Page 6-11, Table 6-2:
Change V1 to HP Part No. 5083-1888.

CHANGE 5

Page 6-11, Table 6-2:
Change V1 to HP Part No. 5083-1874.

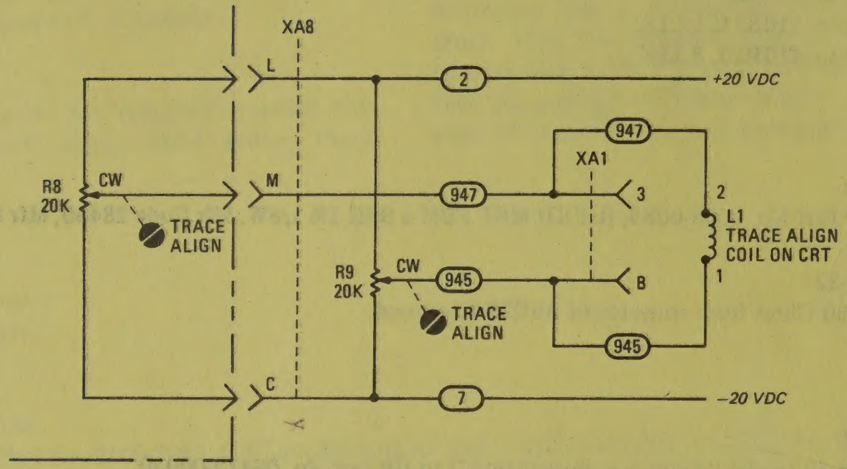
CHANGE 6

Page 6-12, Table 6-2:
Change first item 12 to HP Part No. 08412-00032.
Change first item 23 to HP Part No. 08412-00033.

►CHANGE 7

Page 7-23, Figure 7-24:

Change the circuit configuration of the CRT Trace Align Network as shown in the partial schematic below:



P/O Figure 7-24. Low Voltage Power Supply A8 Schematic Diagram (CHANGE 7)

SAFETY

This instrument has been designed and tested according to IEC Publication 348, "Safety Requirements for Electronic Measuring apparatus," and has been supplied in safe condition. This is a Safety Class I instrument. To ensure safe operation and to keep the instrument safe, the information, cautions, and warnings in this manual must be heeded. Refer to Section I for general safety considerations applicable to this instrument.

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facilities, or to the calibration facilities of other International Standards Organization members.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery. Hewlett-Packard will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office.

PHASE-MAGNITUDE DISPLAY
8412A

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 0990A and 1144A.

With changes described in Appendix I, this manual also applies to instruments with serial numbers prefixed 929- through 976-.

For additional important information about serial numbers see "Instruments Covered by Manual" in Section I.

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1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

Manual Part No. 08412-90018
Microfiche Part No. 08412-90019
Operating Information Part No. 08412–90021

APRIL 1972

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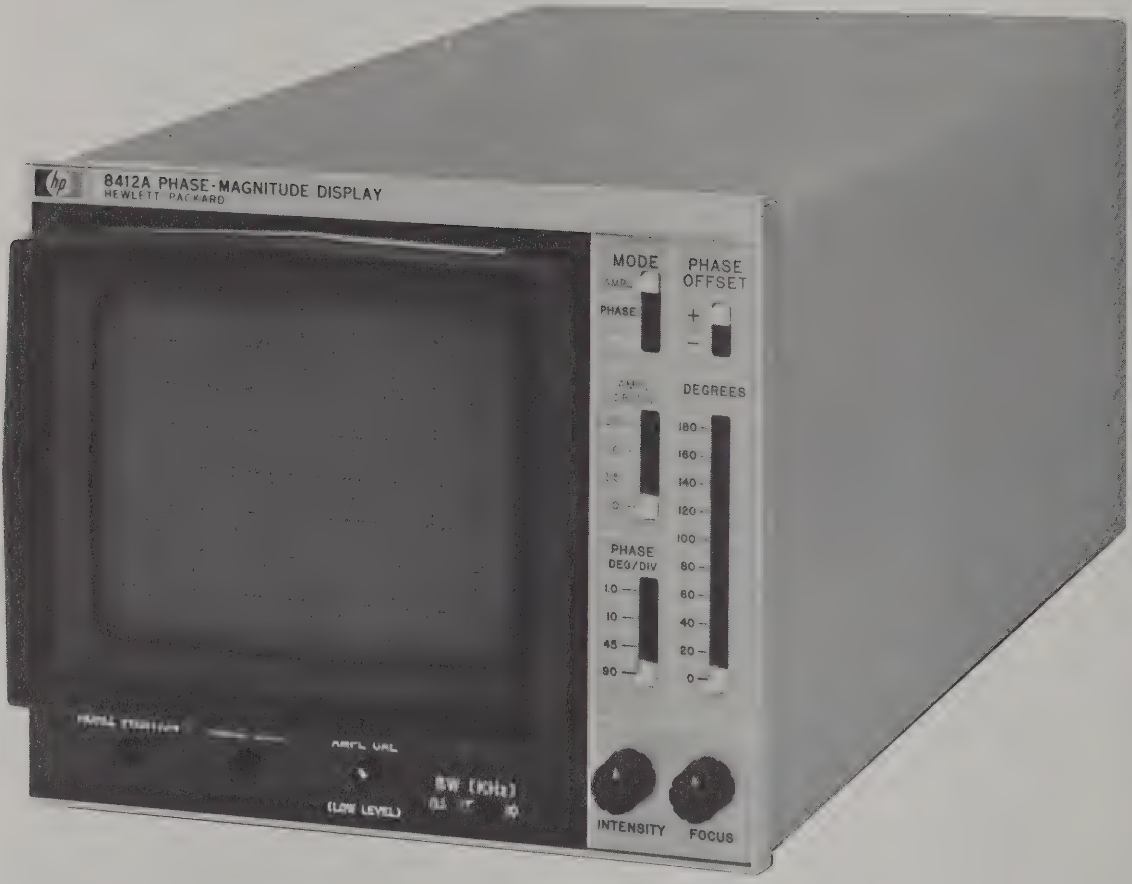


Figure 1-1. Model 8412A Phase-Magnitude Display

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Model 8412A Phase-Magnitude Display (Figure 1-1) is a plug-in display unit for the HP Models 8407A and 8410A Network Analyzers. The instrument contains a CRT which displays test signal amplitude and phase on two separate CRT traces.

1-3. The amplitude and phase display may show signals which represent various amplitude ratios depending on the transducer used in the network analyzer. The displayed quantities may be ratios of voltage, current, impedance, or an incident-to-reflected signal.

1-4. Amplitude is displayed in decibels/division and phase is displayed in degrees/division on the CRT graticule. Various vertical amplifier sensitivity ranges for both amplitude and phase may be selected. Front panel phase offset controls allow the phase to be adjusted for the most convenient display.

1-5. A rear-panel connector accepts a voltage vs. frequency sweep signal from the sweep oscillator and amplifies the signal within the instrument to provide a horizontal sweep for the CRT. Rear panel connectors also provide amplitude and phase output signals and accept Z-axis marker and blanking input signals. Complete specifications for the Model 8412A Phase-Magnitude Display are given in Table 1-1.

1-6. INSTRUMENTS COVERED BY MANUAL.

1.7. Each Phase-Magnitude Display carries a two-part serial number. The number preceding the hyphen, or letter, is a prefix. The contents of this manual apply directly to instruments having the same serial number prefixes as listed after SERIAL NUMBERS on the title page.

1-8. Revision required to adapt this manual to other serial number prefixes are given in a yellow-sheet Manual Changes insert supplied with the manual. For information concerning serial number prefixes not listed on the title page or in an insert, contact your nearest Hewlett-Packard office.

1-9. WARRANTY.

1-10. Terms of the warranty on the 8412A are described on the front cover of this manual. For any additional information converning warranty, contact your nearest Hewlett-Packard field office.

Table 1-1. Specifications (Sheet 1 of 2)

INSTRUMENT FUNCTION: Plug-in CRT display for HP 8407A and HP 8410A Network Analyzers. Displays ratio and phase versus frequency of RF signal.

DYNAMIC RANGE: 80 dB amplitude and ±180 degree phase.

CONTROLS:

MODE: Positions are amplitude, phase, or dual. In dual position, the amplitude trace is more intense than phase for identification.

AMPLITUDE RANGE: 0.25, 1.0, 2.5, and 10 dB/Division.

PHASE RANGE: 1, 10, 45, and 90 DEG/Division.

PHASE OFFSET: Offsets display in 20 degree steps from -180 degrees to +180 degrees.

BANDWIDTH: 10 kHz for maximum information display or 100 Hz to filter displayed noise.

LOW LEVEL AMPLITUDE CALIBRATION: Calibrates low level amplitude signal display.

HORIZONTAL GAIN: Adjusts length of trace.

Table 1-1. Specifications (Sheet 2 of 2)

INPUTS:

SWEEP IN: Requires sweep signal (5V p-p minimum) from sweeper for horizontal sweep drive.

BLANKING: Blanks CRT with -4 Vdc applied. Compatible with HP 8601A and 8690 series sweepers.

Z-AXIS: Intensifies traces with -5 Vdc and blanks with +5 Vdc applied.

OUTPUTS:

AMPLITUDE AUXILIARY: 50 MV/dB

PHASE AUXILIARY: 10 MV/DEGREE

AMPLITUDE ACCURACY:

Display: 0.03 dB/dB ±0.05 div/div.

Rear Output: 0.03 dB/dB.

Temperature Coefficient: Typically $<$0.05 dB/°C at midscreen.

PHASE ACCURACY:

Display: 0.015°/degree ±0.05 div/div.

Rear Output: 0.015°/degree.

Phase Offset: 0.3°/20 degree step, not to exceed total error of 3° for 360° of change, positive or negative direction.

Vs. Displayed Amplitude:
Over upper 70 dB amplitude range: ≤1°/10 dB, maximum phase change not to exceed 4°.
Over full 80 dB amplitude range: Maximum phase change not to exceed 6°.

POWER: 23 Watts supplied by mainframe.

WEIGHT: Net 17 lb. (7, 8 kg); Shipping 22 lb. (10 kg).

DIMENSIONS: 6 in. high, 15-9/16 in. deep, 7-9/32 in. wide (15, 2 x 39, 5 x 18, 6 cm); excludes front panel knobs.

SECTION II

INSTALLATION

2-1. INITIAL MECHANICAL INSPECTION.

2-2. The Phase-Magnitude Display was carefully inspected both mechanically and electrically prior to shipment. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage such as broken controls or connectors and dents or scratches on the panel surface. If damage is evident, refer to Paragraph 2-7 for recommended claim procedure and Paragraph 2-9 for repackaging information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. If the instrument appears undamaged, perform the electrical check (Paragraph 2-3).

2-3. INITIAL ELECTRICAL INSPECTION.

2-4. Check the electrical performance of the Phase-Magnitude Display as soon as possible after receipt by performing the Performance Test (Paragraph 5-4). The Performance Test procedure compares the electrical performance to the specifications of Table 1-1. This test is suitable for incoming quality control inspection. If the Phase-Magnitude Display does not perform within the specifications, refer to Paragraph 2-7 for recommended claim procedure and Paragraph 2-9 for repackaging information.

2-5. PREPARATION FOR USE.

2-6. The 8412A Phase-Magnitude Display mounts in the readout section of the Model 8407A or 8410A Network Analyzer mainframe. To mount the 8412A display, unlock the insertion arm on the front panel of the mainframe and if a different plug-in is installed, remove it. Slide the 8412A into position, then lock the insertion arm in place at the bottom of the display.

2-7. CLAIMS.

2-8. If physical damage is evident, or if the instrument does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard sales and service office. (See list at rear of manual). The sales and service office will arrange for repair or replacement without waiting for settlement of a claim with the carrier.

2-9. REPACKAGING FOR SHIPMENT.

2-10. USING ORIGINAL PACKAGING.

2-11. The same containers and materials used in factory packaging can be obtained through the Hewlett-Packard sales and service offices listed at the rear of this manual. If the Model 8412A is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-12. USING OTHER PACKAGING.

2-13. The following general instructions should be used for repackaging with commercially-available materials:

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard service office or center, attach a tag indicating the type of service required, return address, model number, and full serial number.)

b. Use a strong shipping container. A double-wall carton made of 350 pound test material is adequate.

c. Use enough shock-absorbing material (3- to 4-inch layer) around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely and mark it FRAGILE to assure careful handling.

e. In any correspondence, refer to the instrument by model number and full serial number.

SECTION III

OPERATION

3-1. INTRODUCTION

3-2. The Model 8412A Phase-Magnitude Display is a plug-in unit for the Model 8407A or 8410A Network Analyzer mainframe. The 8412A provides a direct CRT trace of phase and magnitude showing the ratio between the test and reference RF signals applied to the network analyzer. Controls on the front panel provide horizontal positioning and gain, amplitude low level calibration, phase and amplitude display resolution, and phase offset of the phase trace, as well as CRT intensity and focus. Controls on the rear panel provide vertical positioning and aligning the trace with the horizontal graticule. The rear panel contains BNC connectors which allow connection of the sweeper horizontal signal, markers, and blanking. Output signals from the phase and magnitude amplifiers are available at rear panel BNC connectors for use with an external X-Y recorder or oscilloscope.

3-3. PANEL FEATURES

3-4. Front and rear panel controls, connectors, and indicators are described in Figures 3-1 and 3-2. In these figures, the numbers on the illustrations match the description numbers.

3-5. SCREWDRIVER ADJUSTMENTS

3-6. There are three operator screwdriver adjustments on the 8412A, one on the front panel and two on the rear panel.

3-7. The AMPL CAL (LOW LEVEL) control on the front panel adjusts calibration of the amplitude amplifier. To properly adjust this control, set the Network Analyzer test channel gain and amplitude vernier to obtain an 8412A trace on the center graticule line. Decrease the test channel gain in 10 dB steps. With the 8412A AMPL DB/DIV control set to 10, the trace should move down one major division for each step. If not, adjust AMPL CAL (LOW LEVEL) control on front panel. Continue adjusting the test channel gain and AMPL CAL (LOW LEVEL) controls until the trace moves exactly one major division for each 10 dB step, from the center graticule line toward the bottom of the CRT.

3-8. The VERT POS control on the rear panel is adjusted in a manner similar to adjusting the dc balance of a dc coupled oscilloscope. Set the Sweep Oscillator, Network Analyzer, and 8412A controls to obtain a swept amplitude display positioned near the center graticule line. With the 8412A amplitude sensitivity switch (AMPL DB/DIV) set to 0.25, adjust the Network Analyzer amplitude vernier control to position the 8412A trace on the center graticule line. Then set the 8412A AMPL DB/DIV control to 10. If the trace has moved from the center graticule line, recenter it by adjusting the VERT POS control on the rear panel. Continue adjusting the amplitude sensitivity, amplitude vernier, and vertical position controls as described above; adjust for minimum trace change with a change in sensitivity.

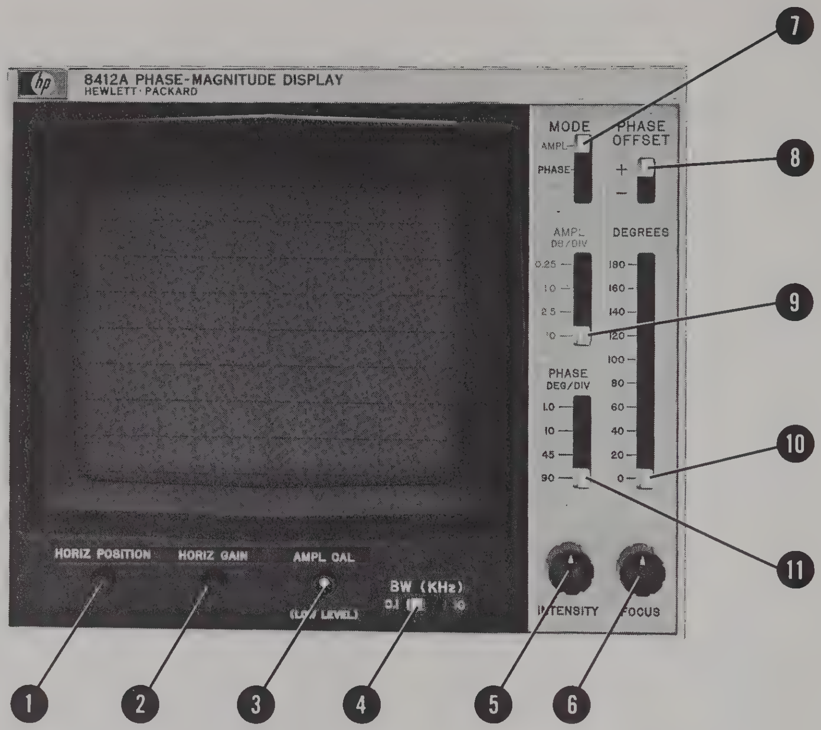
3-9. The TRACE ALIGN control on the rear panel is adjusted to align the 8412A trace to the horizontal graticule. The alignment is done most effectively on the center graticule line. The Sweep Oscillator should be set for minimum sweep width.

3-10. OPERATING PROCEDURES

3-11. The 8412A Phase-Magnitude Display plugs into both the Model 8407A and the Model 8410A Network Analyzers which together cover the entire band between 100 kHz and 12.4 GHz. In an amplitude test setup, the 8412A displays both magnitude and phase. Tests may be made on many types of components and circuits, whether passive or active. Tests may also be made of two matched amplifiers or other devices to see how they differ in gain and phase across a swept band of frequencies. In a reflectometer test setup, the 8412A displays return loss and phase of the reflected signal. From this information, the VSWR, reflection coefficient, and impedance can be calculated. Typical test setups for both reflection and transmission measurements are shown in Figures 3-3 through 3-6.

3-12. In another application, the 8410A together with an 8412A plug-in is used as the readout instrument for an S Parameter Test Set, HP Model 8745A (0.1 - 2 GHz), or for a Reflection/Transmission Test Unit, HP Model 8743A (2.0 - 12.4 GHz). These units test transmission and reflection characteristics of two-port devices. For transmission measurements, the 8412A displays gain or loss in dB and for reflection measurements the 8412A displays gain or loss in dB and for reflection measurements the 8412A displays return loss in dB. For more detailed operating instruction using the 8410A System with an 8743A or 8745A, see the appropriate operating manual for the transmission/reflection instrument used.

FRONT PANEL



① HORIZ POSITION control. Moves trace horizontally.

② HORIZ GAIN control. Adjusts gain of horizontal amplifier to change length of displayed trace.

③ AMPL CAL (LOW LEVEL) control. Adjusts calibration of amplitude amplifier for signals displayed on lower half of CRT screen. Refer to Section III, Paragraph 3-7.

④ BW (kHz) switch. Selects bandwidth passed by the reference and test channels. This allows decreasing bandwidth when necessary to filter noise from the display.

⑤ INTENSITY control. Controls brightness of the trace.

⑥ FOCUS control. Controls the sharpness of the trace.

⑦ MODE switch. Selects AMPL (amplitude), PHASE, or both amplitude and phase (DUAL) to display on screen. When both amplitude and phase are displayed, the amplitude trace is brighter than the phase trace for easy identification.

⑧ PHASE OFFSET polarity switch. From zero degrees, offset is selected either in the negative or positive direction up to 180 degrees. The polarity switch selects the direction from zero and works in connection with the DEGREES switch to select offset.

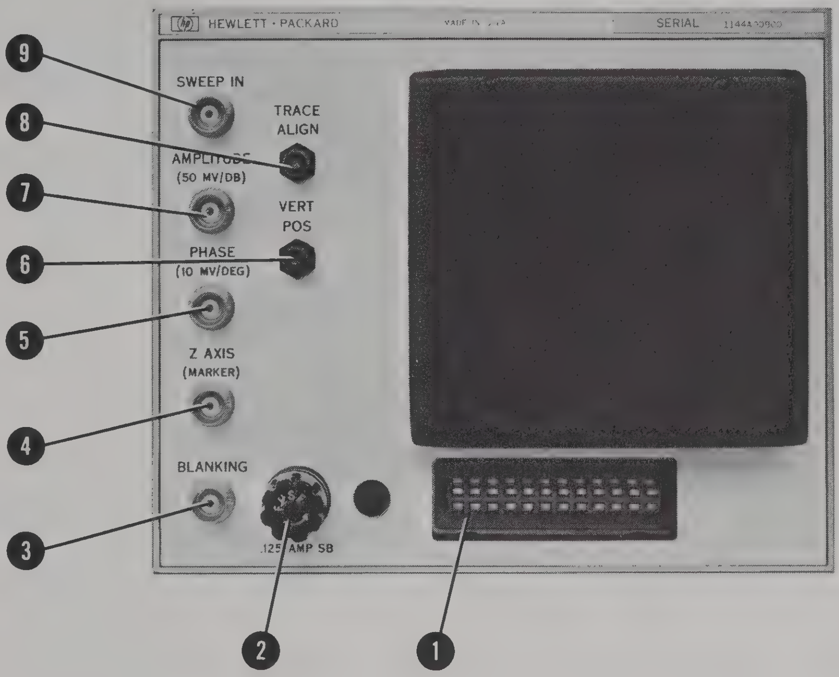
⑨ AMPL DB/DIV. switch. Selects the calibrated resolution of the test channel amplitude display.

⑩ PHASE OFFSET DEGREES switch. Selects offset in 20-degree steps. The switch works in conjunction with the PHASE OFFSET polarity switch to select up to 180 degrees in either the positive or negative direction from zero degrees. The phase offset plus the display reading gives the measured phase reading.

⑪ PHASE DEG/DIV. switch. Selects the calibrated resolution of phase display.

Figure 3-1. Model 8412A Front Panel Features

REAR PANEL



① Mainframe interface connector J1. Makes all necessary connections with 8407A or 8410A mainframe.

② Fuse holder. Fuse protection in 175 Vac line from mainframe. Fuse is 1/8 ampere slow blow.

③ BLANKING connector J6. Input for blanking signal from sweeper. The signal blanks the trace during sweeper retrace (-4V blanks, 0V unblanked).

④ Z-AXIS connector J5. Marker input to Z-axis that intensity modulates the trace, placing a bright dot on the trace at the selected marker frequency with HP Model 8690A/B. The input can both mark and blank (-5V intensifies, +5V blanks).

⑤ PHASE (10 MV/DEG) connector J4. Voltage output is proportional to the phase angle of the test signal compared to the reference signal. Output is 10 mV/degree positive voltage for phase angles of 0 to +180 degrees and negative voltage for angles of 0 to -180 degrees.

⑥ VERT POS Control. Zeroes phase and amplitude traces vertically. Refer to Section III, Paragraph 3-8.

⑦ AMPLITUDE (50 MV/DB) connector J3. Depending on the transducer used on the unit under test, the voltage output is proportional to the amplitude ratio of:

(1) $\left[20 \log_{10} (V_{TEST}/V_{REF})\right]$,

(2) $\left[20 \log_{10} (I_{TEST}/I_{REF})\right]$, or

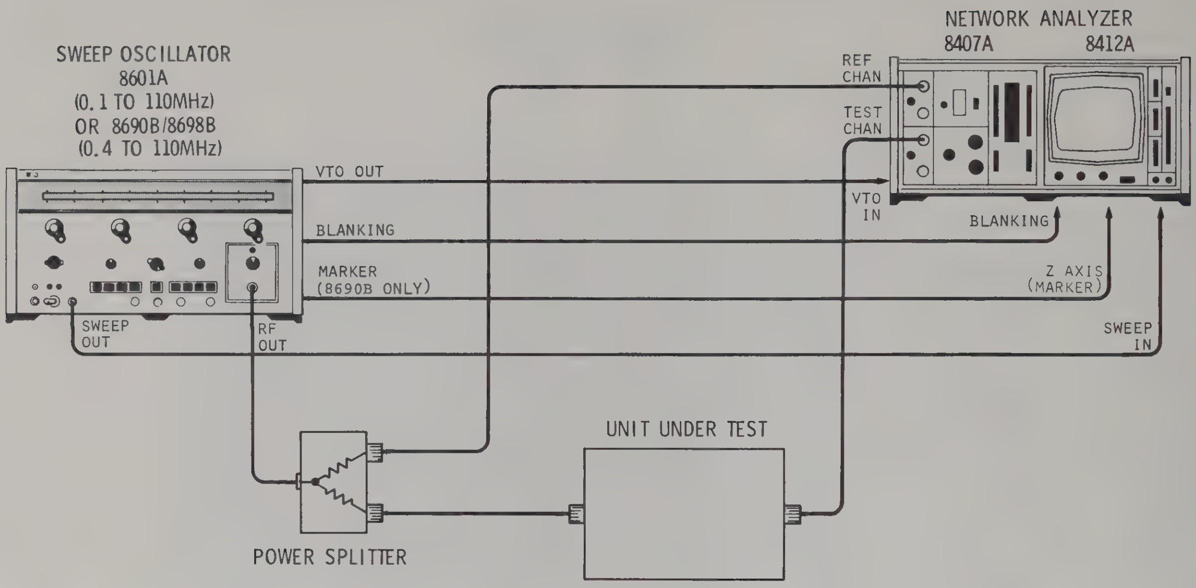
(3) $\left[20 \log_{10} (V_{RETURN}/V_{INCIDENT})\right]$.

⑧ TRACE ALIGN Control. Used to align CRT trace to the horizontal graticule. Adjustment should be performed with sweep oscillator set for minimum sweep width.

Refer to Section III paragraph 3-9.

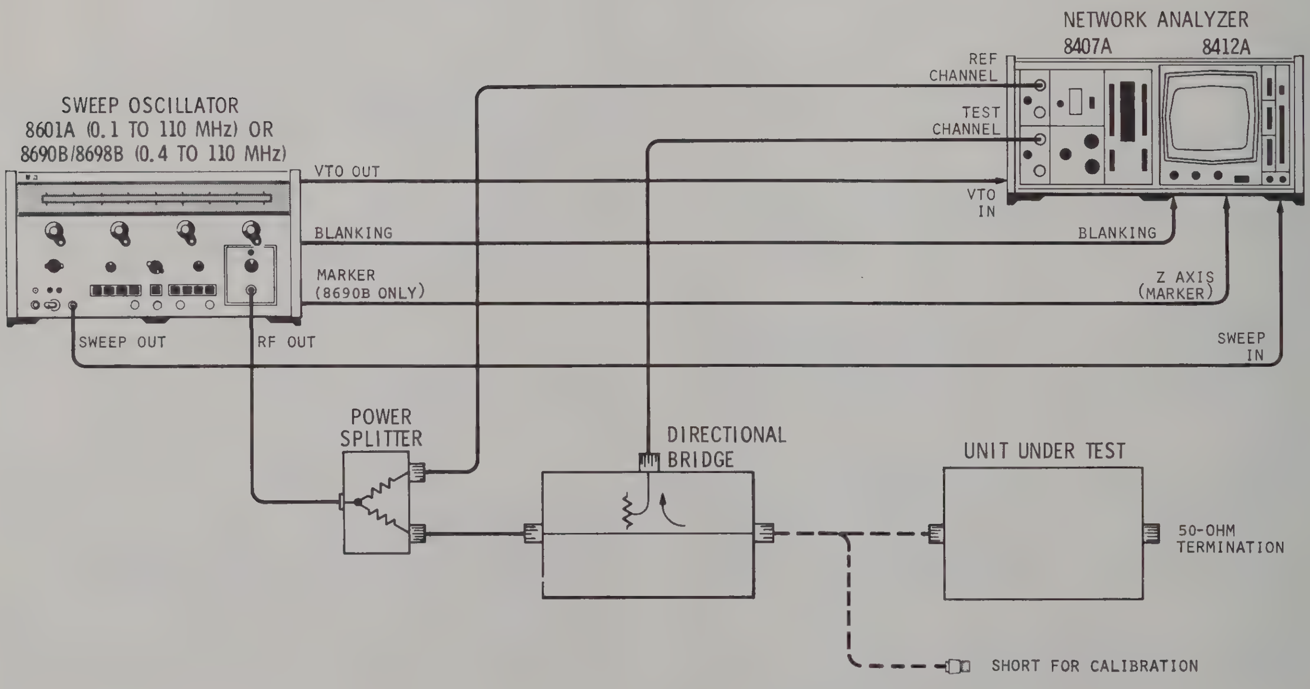
⑨ SWEEP IN connector J2. Input for sweeper signal that goes to horizontal (x-axis) amplifier.

Figure 3-2. Model 8412A Rear Panel Features



NOTE: POWER SPLITTER AND INTERCONNECTION CABLES ARE PART OF ACCESSORY KIT HP 11651

Figure 3-3. Typical Transmission Test Setup Using 8407A/8412A



NOTE: POWER SPLITTER, DIRECTIONAL BRIDGE AND INTERCONNECTING CABLES ARE PART OF ACCESSORY KIT HP 11652

Figure 3-4. Typical Reflection Test Setup Using 8407A/8412A System

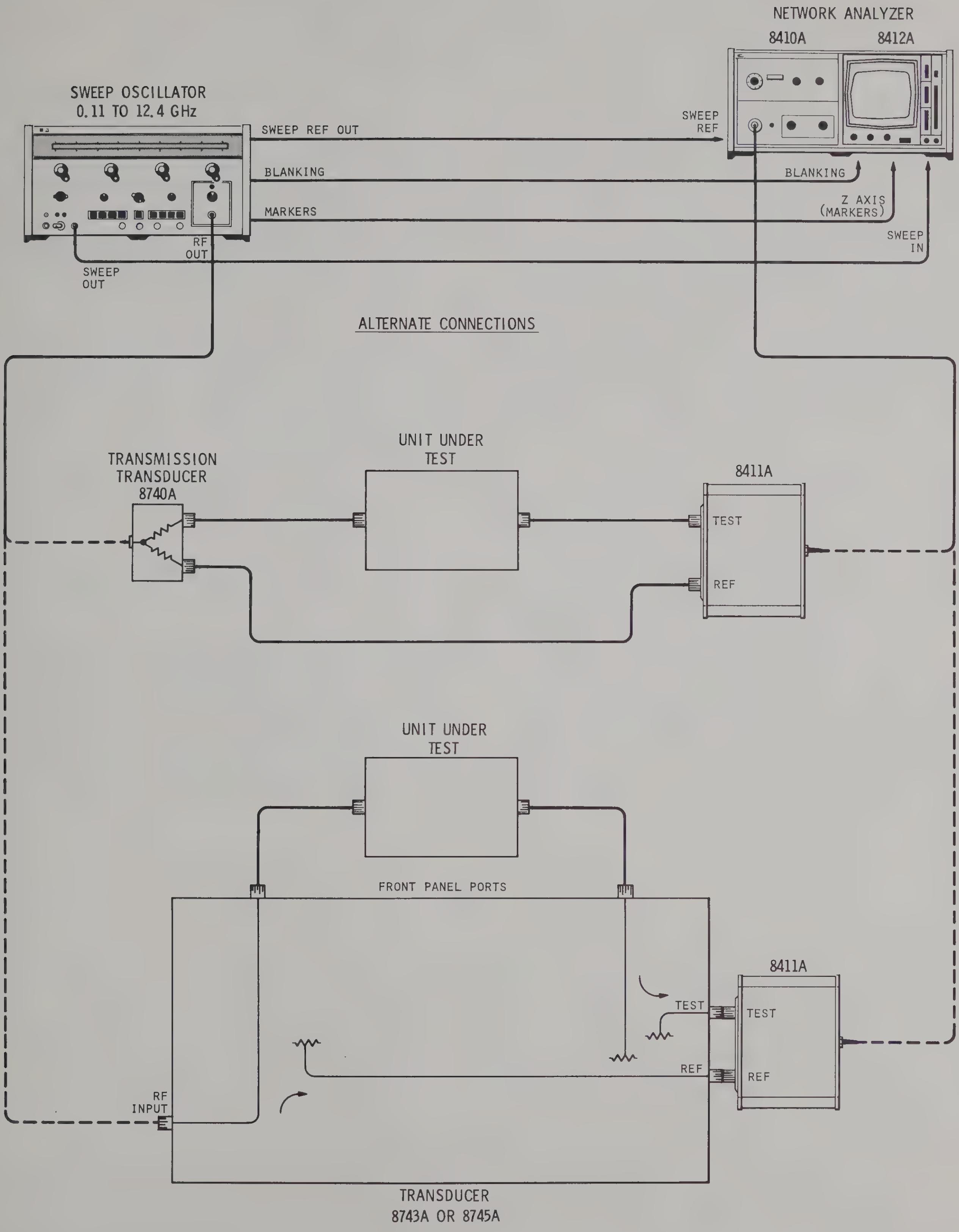


Figure 3-5. Typical Transmission Test Setup Using 8410A/8411A/8412A System

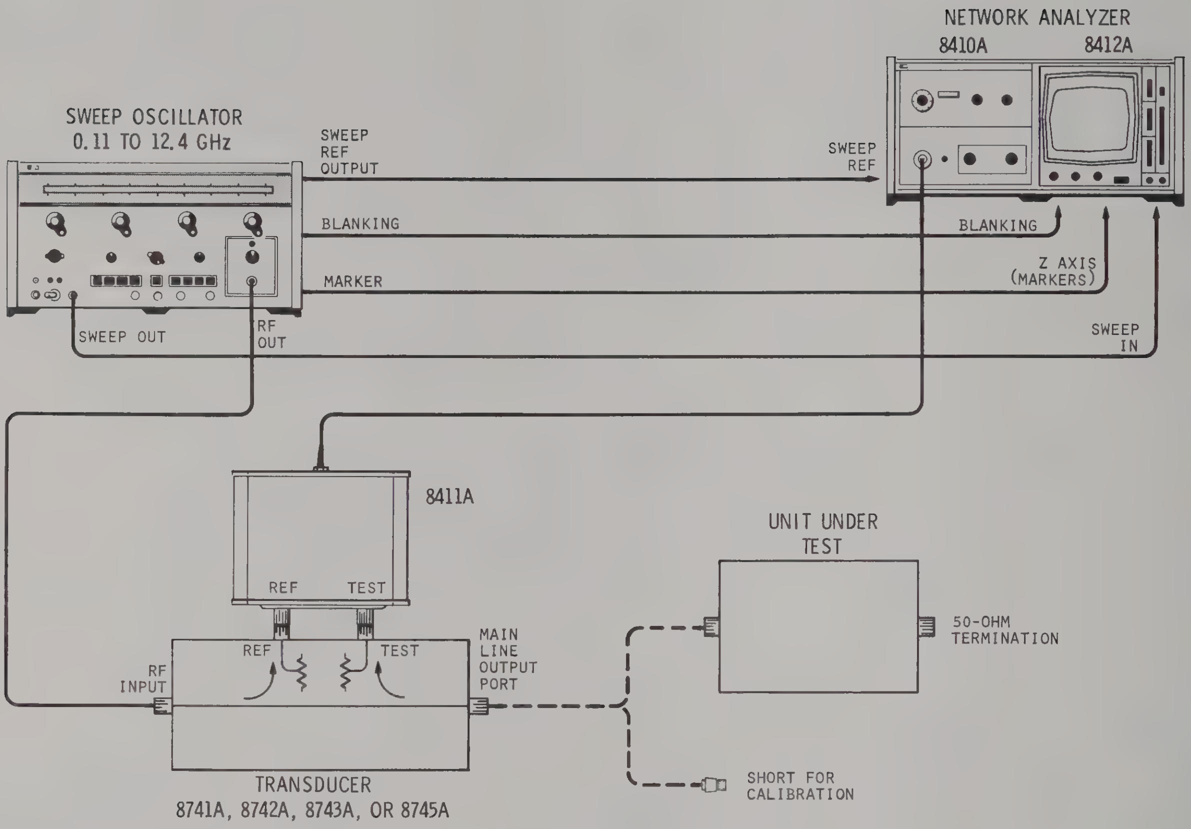


Figure 3-6. Typical Reflection Test Setup Using 8410A/8411A/8412A System

SECTION IV

PRINCIPLES OF OPERATION

4-1. GENERAL.

4-2. The Model 8412A Phase-Magnitude Display detects and displays magnitude and phase differences inherent in the RF input signals to the mainframe. This is accomplished by detecting the 278 kHz IF test and reference signals, multiplexing them into the vertical amplifier, and displaying the relative magnitude and phase on two separate traces on the CRT.

4-3. Inputs on the rear panel are provided for blanking and frequency marking of the CRT trace. Outputs allow display on an external recorder or oscilloscope. The horizontal sweep is driven by a dc voltage vs. frequency sweep signal from the external sweep oscillator. A simplified block diagram of the 8412A is shown in Figure 4-1. A more detailed theory of operation is presented in Section VII opposite the individual schematic diagrams.

4-4. SIMPLIFIED BLOCK DIAGRAM DESCRIPTION.

4-5. As shown in Figure 4-1, RF input signals from a unit under test are converted to 278 kHz IF signals by the HP 8407A or 8410A Network Analyzer mainframe then applied to the 8412A plug-in display. The network analyzer mainframe also supplies dual channel automatic gain control (AGC) so that only the test channel amplitude need be measured to effectively measure the test-to-reference amplitude ratio.

4-6. The test channel is separated into two signal channels in the mainframe, the test phase signal and the test amplitude signal. The test phase signal is amplified and limited in the 8412A test channel amplifier A9. Two functions are accomplished; (1) a very fast zero crossing is obtained which is used for phase measurement, and (2) a square-wave constant-amplitude signal is obtained which is used for the drive signal in the amplitude detector. The second test channel input, the test amplitude signal, is amplified then detected in amplitude synchronous detector A10, using the drive from A9. The detected amplitude signal is converted in amplitude-channel log converter A7 to a logarithmic signal read in decibels. The logarithmic amplitude information is then multiplexed together with the phase information in multiplexer A3 and displayed on the CRT.

4-7. The reference phase channel passes through phase offset A2. The output of phase offset A2 is applied to phase detector A1 where it is compared with the test channel phase signal from A9. The phase information at the output of the phase detector is applied to multiplexer-deflection amplifier A3 along with the amplitude information. Multiplexer-deflection amplifier A3 time-multiplexes the phase and amplitude signals to the CRT where they are displayed.

4-8. The network analyzer mainframe (8407A or 8410A) also supplies ±20 Vdc and 175 Vac to the 8412A. The high-voltage power supply A5 and high-voltage rectifier A6 convert plus and minus 20 Vdc to -3000 Vdc for the CRT. Low-voltage power supply A8 converts the 175 Vac to ±6 Vdc and 135 Vdc for other circuit requirements within the instrument.

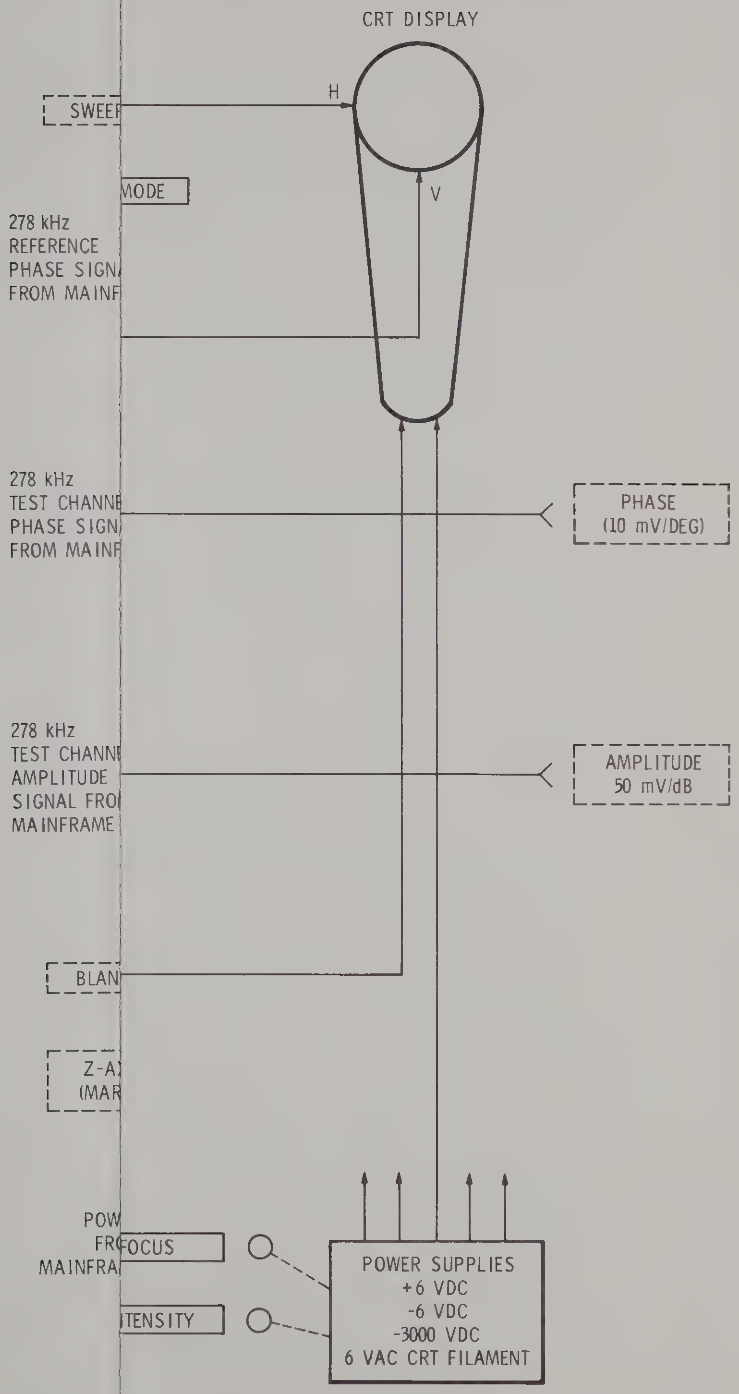


Figure 4-1. Model 8412A Simplified Block Diagram

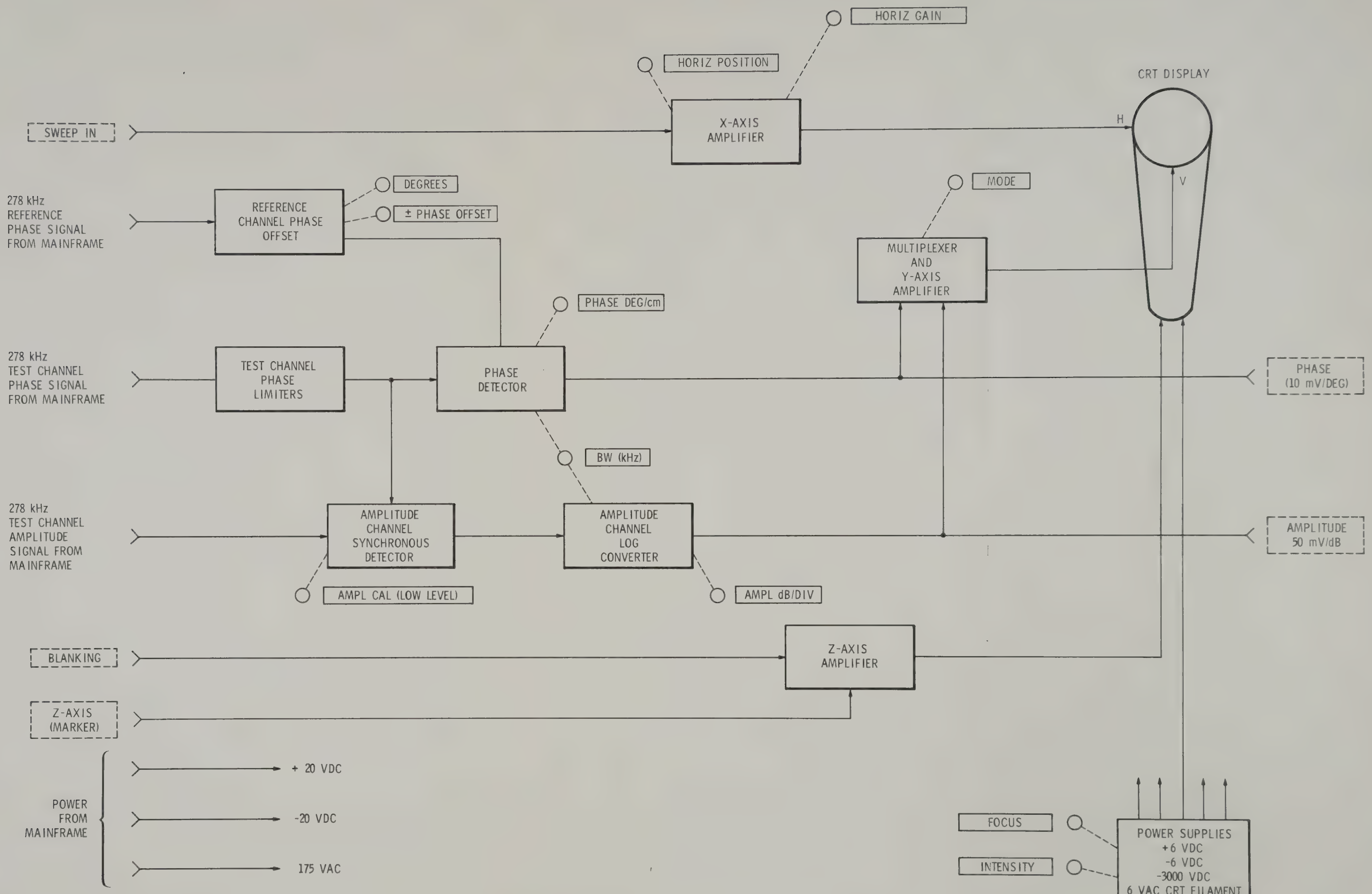

HORIZ GAIN
HORIZ POSITION
CRT DISPLAY
SWEEP IN
X-AXIS AMPLIFIER
H
V
278 kHz REFERENCE PHASE SIGNAL FROM MAINFRAME
REFERENCE CHANNEL PHASE OFFSET
DEGREES
± PHASE OFFSET
MODE
MULTIPLEXER AND Y-AXIS AMPLIFIER
PHASE DEG/cm
278 kHz TEST CHANNEL PHASE SIGNAL FROM MAINFRAME
TEST CHANNEL PHASE LIMITERS
PHASE DETECTOR
PHASE (10 mV/DEG)
BW (kHz)
278 kHz TEST CHANNEL AMPLITUDE SIGNAL FROM MAINFRAME
AMPLITUDE CHANNEL SYNCHRONOUS DETECTOR
AMPLITUDE CHANNEL LOG CONVERTER
AMPLITUDE 50 mV/dB
AMPL CAL (LOW LEVEL)
AMPL dB/DIV
BLANKING
Z-AXIS AMPLIFIER
Z-AXIS (MARKER)
POWER FROM MAINFRAME
+ 20 VDC
-20 VDC
175 VAC
FOCUS
INTENSITY
POWER SUPPLIES +6 VDC -6 VDC -3000 VDC 6 VAC CRT FILAMENT

Figure 4-1. Model 8412A Simplified Block Diagram

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides instructions for performance testing, calibration, and troubleshooting of the HP 8412A Phase-Magnitude Display. Test equipment required for these procedures is listed in Table 5-2. If the test equipment recommended is not available, other equipment may be used if its performance meets the "Critical Specifications" listed in the table.

5-3. PRINTED CIRCUIT BOARD EXCHANGE.

5-4. The 8412A is unique in that the printed circuit boards of the instrument have been carefully designed to be independent of each other so that problems can be easily isolated to the board level. HP encourages the use of the troubleshooting tree in Section VII for isolating problems to the board level and has made rebuilt-exchange printed circuit boards available to complement this repair approach. The rebuilt-exchange boards are available at a much reduced cost from a new board. The lower price is dependent on the return of the defective board to HP. A replacement board should be ordered by the rebuilt-exchange stock number listed in Table 5-1. The board can be ordered through the nearest Hewlett-Packard Sales and Service office listed in the back of this manual. The exchange board will immediately be sent directly from our stock of service parts. Upon receiving the replacement board, the faulty board should be returned in the same special carton in which the new board was received. Do not return a defective board to HP until the replacement board has been received.

5-5. If a defective exchange board will not be returned to HP and the ordered board is for spare parts stock, etc., a new board should be ordered, using the new-assembly stock number listed in Table 5-1 or 6-1.

5-6. MAINTENANCE PRECAUTIONS.

WARNING

> Voltages greater than 1000 Volts are present at the CRT and in assemblies A5 and A6. These voltages could cause injury to personnel.

CAUTION

> When replacing bottom covers, do not exceed screw strength.

5-7. PERFORMANCE TESTS.

5-8. The procedures in Table 5-3 and 5-4 test the performance of the 8412A. These procedures may be used during incoming inspection, periodic evaluation, or after repair or alignment. The test may be performed without access to the instrument interior. The specifications of Table 1-1 are the performance standards.

5-9. Two similar procedures are presented, one for the 8407A mainframe (Table 5-3) and one for the 8410A mainframe (Table 5-4). The two procedures differ only because of the differences in operation between the two mainframes.

5-10. ALIGNMENT PROCEDURES.

5-11. Alignment procedures are given in Table 5-6 and 5-7. These procedures should not be performed as a routine maintenance procedure but should be used (1) after replacement of a part or component, (2) when the performance test shows that the specifications of Table 1-1 cannot be met, or (3) when instructed to do so in the troubleshooting tree (Figure 7-4). Before attempting any adjustment, allow 30 minutes warm-up time for the 8412A and mainframe.

5-12. Table 5-2 lists the test equipment required for alignment, Table 5-4 lists the alignment controls, and Figure 5-3 shows the location of the controls.

5-13. TROUBLESHOOTING.

5-14. The troubleshooting procedures are given in Figure 7-4. They should be performed in the order given, since each step presumes the proper readout in preceding steps. The troubleshooting tree should isolate trouble to a defective printed circuit board or chassis-mounted part. If further fault isolation is desired, use the individual schematic diagram for the defective board and troubleshoot, using the waveforms and voltages on the schematic diagram. The troubleshooting tree assumes that chassis wiring and cabling is not defective. If this type of trouble occurs, use standard troubleshooting techniques to locate trouble.

5-15. SELECTED COMPONENTS.

5-16. Some component values are selected during manufacturing in order to achieve a desired circuit performance. The typical value used in a circuit is shown on the schematic, along with a star after the value. These components are listed in the parts list as "factory selected".

5-17. In the 8412A only A5R2 is factory selected. A change in this value changes the acceleration voltage to the CRT. If the vertical amplifier in A3 cannot deflect the trace to the top and bottom of the CRT screen, the value of A5R2 may be increased up to a maximum of 85K ohm. Conversely, the value of A5R2 may be decreased to 21K ohm minimum, depending on the vertical deflection of the CRT trace.

Table 5-1. Rebuilt-Exchange Assembly Stock Numbers

Assembly	New Stock No.	Rebuilt-Exchange Stock No.
A1 Phase Detector	08412-60001	08412-60030
A2 Phase Offset	08412-60002	08412-60031
A3 Multiplexer/Deflection Amp.	08412-60003	08412-60032
A4 Function Switch	08412-60011	08412-60044
A4A1 Switch Assembly	08412-60012	08412-60045
A5 HV Power Supply	08412-60005	08412-60034
A6 HV Rectifier	08412-60006	08412-60035
A7 Log Converter	08412-60007	08412-60036
A8 LV Power Supply	08412-60008	08412-60037
A9 Test Channel Amp.	08412-60009	08412-60038
A10 Synch. Detector	08412-60010	08412-60039

Table 5-2. Recommended Test Equipment

Item	Instrument	Critical Specifications	Recommended HP Model
1.	Dual-trace Oscilloscope with 10 pF 10:1 probes	Vertical Amplifier: Dual trace Bandwidth: 20 MHz minimum Horizontal Sweep Rate: 0.2 μS/cm Vertical Sensitivity: 5mV/cm	180A/1801A/1820A
2.	DC Digital Voltmeter	Accuracy: 0.05% Input Impedance: 10 megohms min. Automatic Range Selection: Range to 150V	3439A/3443A
3.	Power Supply	Output: ±5 Vdc at 50mA	721A
4.	DC Voltmeter with High Voltage Probe	Range: 4000 Vdc Current Drain: 2.5 μA maximum Accuracy: ±5%	410C with 11044A high voltage probe.
5.	Service Cable (Supplied with 8407A & 8410A)		08410-6032
USED WITH 8407A MAINFRAME ONLY			
6.	Network Analyzer		8407A
7.	11651A Transmission Kit	Includes 50 ohm power splitter and two matched, double shielded cables.	11651A

Table 5-2. Recommended Test Equipment (Contd)

Item	Instrument	Critical Specifications	Recommended HP Model
8.	Sweep Oscillator	Range: 0.1 to 110 MHz (any part) RF Output: +20 dBm VTO Output: Tracks 200 MHz from RF Output signal.	8601A (0.1 to 110 MHz) 8690B/8698B (0.4 to 110 MHz)
USED WITH 8410A MAINFRAME ONLY			
9.	Network Analyzer with Harmonic Frequency Converter		8410A/8411A
10.	Sweep Oscillator	Range: 0.11 to 12.4 GHz (any part) RF Output: 25mW into 50 ohm Sweep Width: One Octave min.	8690B/8699B (0.1 to 4 GHz) 8690B/8693A (4 to 8 GHz) 8690B/8694A (8 to 12.4 GHz)
11.	Transducer (Power Splitter)	Impedance: 50 ohms	8740A (dc to 12.4 GHz) 8741A (0.11 to 2 GHz) 8742A (2 to 12.4 GHz) 8743A (2 to 12.4 GHz) 8745A (0.1 to 2 GHz)

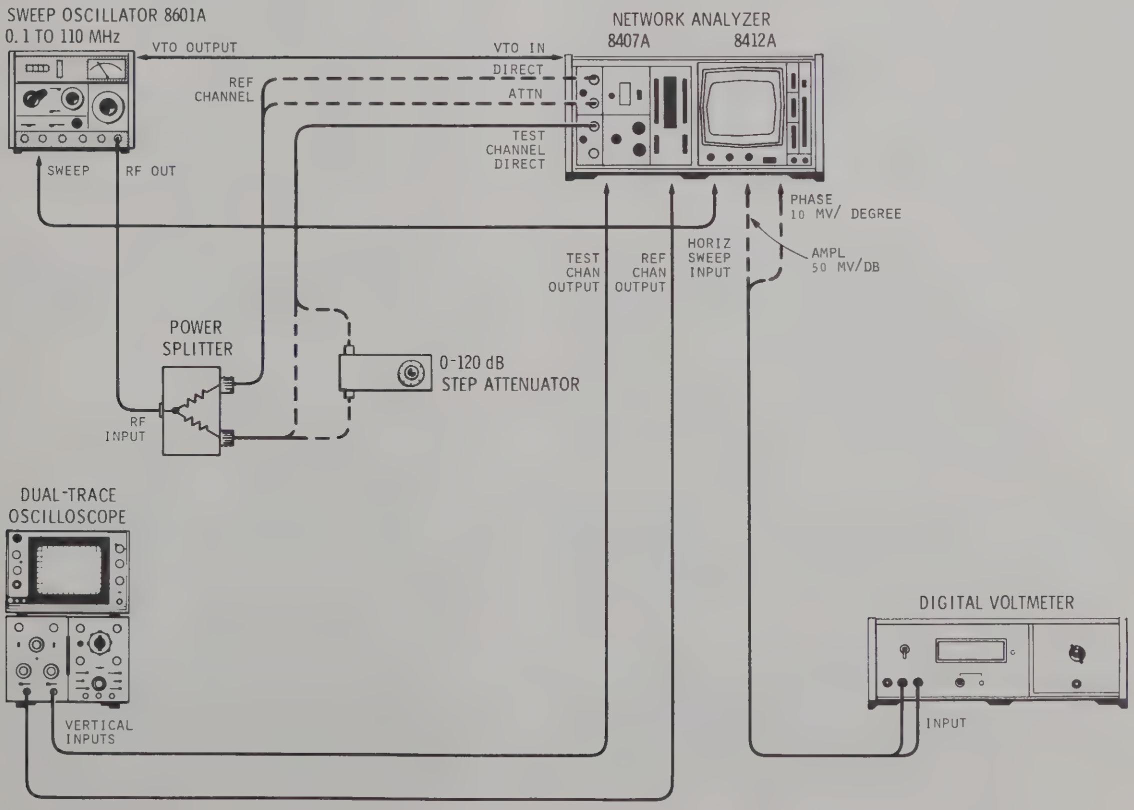


Figure 5-1. Equipment Setup for Performance Test with 8407A Mainframe

Table 5-3. Performance Test with 8407A Mainframe (Sheet 1 of 6)

STEP	DESCRIPTION AND PROCEDURE
1.	INITIAL SETUP SPECIFICATIONS: General operation. DESCRIPTION: Set up and adjust instrument for amplitude and phase trace on CRT. PROCEDURE: a. Connect equipment as shown in Figure 5-1. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set the 8407A AMPL VERNIER to midrange, set DISPLAY REFERENCE CAL controls for zero dB at top DISPLAY REFERENCE switch position, and set DISPLAY REFERENCE switches to +10 dB. (One step down from top on 10 dB/step switch and top position on 1 dB/step switch.) Set 8407A REF CHANNEL LEVEL RANGE switch to the middle position. Adjust sweep oscillator RF output for REF CHAN LEVEL meter indication at the top of the OPERATE range. If UNCAL REDUCE INPUT RATIO light comes on, reduce sweep oscillator RF power or change position of REF CHAN LEVEL range switch to a lower position to cause the light to go out. b. The 278 kHz sine wave signal from the 8407A IF TEST OUTPUT should be ≥0.07V p-p and the IF REF OUTPUT should be ≥1.0V p-p on oscilloscope. c. Set 8412A MODE switch to DUAL, AMPL DB/DIV switch to 10, PHASE DEG/DIV switch to 90, PHASE switch to +, DEGREES switch to 100, and BW (kHz) switch to 10. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB position. Both amplitude and phase traces should be displayed across 8412A CRT. Adjust the HORIZ POSITION and HORIZ GAIN controls so that the ends of the trace are at the two edge graticules. Adjust 8412A FOCUS control and both traces should be in good focus. The amplitude trace should be brighter than the phase trace.
2.	TRACE ALIGN SPECIFICATIONS: General operation. DESCRIPTION: Check that CRT circuits are properly aligned by adjusting trace to superimpose center graticule line. PROCEDURE: Set 8412A MODE switch to AMPL. Adjust 8407A AMPL VERNIER and DISPLAY REFERENCE 1 dB/step controls to superimpose the amplitude trace over the center horizontal graticule. The trace should align with the graticule within 1 mm of the trace except at the very end points.
3.	AMPLITUDE TEST SPECIFICATIONS: ±.03 dB/dB and ±0.05 division/division; auxiliary output ±.03 dB/dB. DESCRIPTION: The accuracy of the rear panel output is checked then the CRT amplitude trace is checked through the 80 dB amplitude range. All of the amplitude resolution ranges are then checked for calibration. PROCEDURE: a. Connect digital voltmeter (DVM) to 8412A AMPL 50 MV/DB rear-panel output. Set sweep oscillator for single-frequency CW operation. Adjust 8407A DISPLAY REFERENCE 1 dB/step and AMPL VERNIER control for 0.000 Vdc on DVM. Check DVM readout at 8407A DISPLAY REFERENCE 10 dB/step control settings listed in table on following page. If necessary, adjust 8412A front panel AMPL CAL (LOW LEVEL) control for DVM indication within tolerance at positions of +40 to +80 dB on 8407A DISPLAY REFERENCE control.

Table 5-3. Performance Test with 8407A Mainframe (Sheet 2 of 6)

STEP	DESCRIPTION AND PROCEDURE
3. (Contd)	

8407A DISPLAY REFERENCE 10 dB/step (Top Switch Position is zero dB)	Digital Voltmeter Reading
0	+2.000 ± .060
+10	+1.500 ± .045
+20	+1.000 ± .030
+30	+0.500 ± .015
+40	0.000 ± .005
+50	-0.500 ± .015
+60	-1.000 ± .030
+70	-1.500 ± .045
+80	-2.000 ± .060

b. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB. Set MODE switch to AMPL. Adjust 8407 AMPL VERNIER for the trace superimposed on the center graticule line. Check trace position at 8407A DISPLAY REFERENCE 10 dB/step control settings listed in table below. If necessary, adjust 8412A front panel AMPL CAL (LOW LEVEL) control for CRT trace within tolerance at positions of +40 to +80 dB on 8407A DISPLAY REFERENCE control.

8407A DISPLAY REFERENCE 10 dB/step (Top Switch Position is zero dB)	Tolerance of 8412A Trace To Major Graticule Division
0	±0.2 DIV
+10	±0.15 DIV
+20	±0.1 DIV
+30	± .05 DIV
+40	± .05 DIV
+50	± .05 DIV
+60	±0.1 DIV
+70	±0.15 DIV
+80	±0.2 DIV

c. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB and set 8412A AMPL DB/DIV switch to 2.5. Adjust 8407A AMPL VERNIER to superimpose the trace on the center CRT graticule. Change 8407A DISPLAY REFERENCE 10 dB/step control to +30 dB position. The 8412A trace should move up four major graticule divisions ±0.5 small graticule division.

d. Set 8412A AMPL DB/DIV switch to 1.0 and set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB. If necessary, readjust 8407A AMPL VERNIER to superimpose the trace on the center CRT graticule. Change 8407A DISPLAY REFERENCE 1 dB/step control to +1 dB. The 8412A trace should move down one major division.

Table 5-3. Performance Test with 8407A Mainframe (Sheet 3 of 6)

STEP	DESCRIPTION AND PROCEDURE
3. (Contd)	e. Set 8412A AMPL DB/DIV switch to 0.25 position. Set 8407A DISPLAY REFERENCE 1 dB/step control to zero and 10 dB/step control to 40. Adjust 8407A AMPL VERNIER control to place the amplitude trace on the middle CRT graticule. Change the 8407A DISPLAY REFERENCE 1 dB/step control to +1 dB and 8412A trace should move down four major graticule divisions ± one small division.

4.

PHASE TEST

SPECIFICATIONS: ±.015 degrees/degree ±.05 divisions/division, $\leq$ 3 degrees cumulative; auxiliary output ±.015 degree/degree.

DESCRIPTION: The accuracy of the rear panel output is checked, then the CRT trace is checked through 360 degrees. All of the phase resolution ranges are then checked for calibration.

PROCEDURE:

a. Set sweep oscillator to single-frequency (CW) operation. Connect DVM to PHASE 10 MV/DEG connector at rear panel of 8412A. On 8412A, set MODE switch to PHASE, PHASE DEG/DIV switch to 90, and DEGREES switch to zero. Set 8407A DISPLAY REFERENCE CONTROLS for an on-screen amplitude display. Adjust 8407A PHASE VERNIER control to obtain .000 Volt on DVM. Set PHASE DEG/DIV switch to 1. Adjust sweep oscillator RF output for the smallest phase dot on 8412A screen (best signal to noise ratio). The 8407A REFERENCE CHANNEL LEVEL meter should indicate near the top of the OPERATE range.

b. Set 8412A DEGREES switch to 180 and PHASE DEG/DIV switch to 90. Set PHASE switch from positive to negative. The dot on the 8412A should be erratic, showing a thin vertical line. Adjust 8407A PHASE VERNIER slightly back and forth from in-phase position and observe trace dot become distinct on either side of in-phase condition.

c. Set 8412A DEGREES switch to zero. Make slight adjustment of 8407A PHASE VERNIER for 0.000 DVM indication. Set PHASE switch from positive (+) to negative (-) and DVM should indicate .000 Volt ± .003 Volt in both positions.

d. Set PHASE switch to positive position. Set DEGREES switch to positions shown in table below and obtain DVM indication as shown. Set PHASE switch to negative (-) position and recheck DVM indication at each position of DEGREES switch.

DEGREES Setting	DVM Indication
0	.000 ± .003
20	0.200 ± .003
40	0.400 ± .006
60	0.600 ± .009
80	0.800 ± .012
100	1.000 ± .015
120	1.200 ± .018
140	1.400 ± .021
160	1.600 ± .024

Table 5-3. Performance Test with 8407A Mainframe (Sheet 4 of 6)

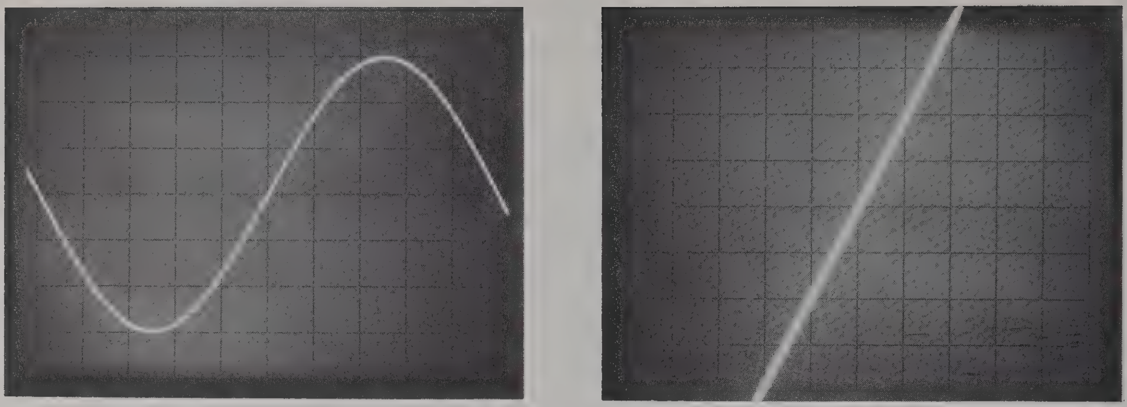
STEP	DESCRIPTION AND PROCEDURE
4. (Contd)	e. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set DEGREES switch to each switch position and note the phase trace movement. It should change by two large graticules for 180 degree offset. (Each small division is 18 degrees.) f. Set PHASE DEG/DIV switch to 45. Change DEGREES switch by 180 degrees and phase trace should move four large graticule divisions. g. Set PHASE DEG/DIV switch to 10. Change DEGREES switch by 20 degrees and phase dot should move two major graticule divisions. h. Check the 1 DEG/DIV range of the phase circuit by comparing its accuracy to the 10 DEG/DIV range as follows. Set DEGREES switch to zero and PHASE DEG/DIV switch to 10. Adjust the 8407A PHASE VERNIER to place the trace two small graticule lines below the center graticule line. Set PHASE DEG/DIV switch to 1 and trace should move to the bottom graticule line.
5.	BANDWIDTH SWITCH TEST SPECIFICATIONS: General operation. DESCRIPTION: The change in frequency response is observed on the CRT trace when a low-pass filter is connected in both channels. PROCEDURE: Set signal source for swept mode with sweep width of 10 kHz or less. Set 8407A DISPLAY REFERENCE controls to +40 dB. Set 8412A MODE switch to DUAL, AMPL DB/DIV switch to 0.25, PHASE DEG/DIV to 1, PHASE polarity switch to positive (+), DEGREES switch to zero, and BW (kHz) switch to 10. Adjust 8407A AMPL VERNIER and DISPLAY REFERENCE 1 dB/step switch to place amplitude trace on screen. Both phase and amplitude traces should be on 8412A and both traces should be jagged, showing normal noise on test channel. Set BW (kHz) switch to 0.1 and both amplitude and phase trace should change to continuous smooth traces due to the low-pass filter connected across the amplifier inputs.
6.	BLANKING TEST SPECIFICATIONS: General operation. DESCRIPTION: A voltage simulating a blanking pulse is applied to the rear-panel blanking input and the CRT trace should blank. PROCEDURE: Connect a -4 Vdc supply to 8412A rear-panel BLANKING connector and -4 Vdc return to ground. The traces should be blanked. Disconnect -4 Vdc supply.
7.	Z-AXIS MODULATION TEST SPECIFICATION: General operation. DESCRIPTION: Voltages simulating marker or blanking pulses are applied to the rear-panel Z-AXIS input and the CRT trace intensifies or blanks. PROCEDURE: a. Connect a -5 Vdc supply to 8412A rear-panel Z-AXIS connector and -5 Vdc return to ground. The traces should intensify. b. Connect +5 Vdc to 8412A rear-panel Z-AXIS connector and +5 Vdc return to ground. The traces should blank.

Table 5-3. Performance Test with 8407A Mainframe (Sheet 5 of 6)

STEP	DESCRIPTION AND PROCEDURE
8.	PHASE CHANGE DUE TO AMPLITUDE CHANGE SPECIFICATION: a. Over upper 70 dB amplitude range: ≤1°/10 dB, maximum phase change not to exceed 4°. b. Over full 80 dB amplitude range: Maximum phase change not to exceed 6°. NOTE Phase error due to amplitude change in the Model 8412A can not be measured accurately independent of the phase error contributed by the Model 8407A. Therefore, this test measures the combined phase error of the Models 8407A and 8412A. A test procedure starting at step (j) explains how to measure error contributed by 8407A. DESCRIPTION: Test channel power is varied in 10 dB steps while observing the 8412A phase indication. PROCEDURE: a. Connect equipment as shown on page 5-3, Figure 5-1, with reference input signal to REF CHANNEL DIRECT (0-120 dB attenuator not used). b. Set 8407A REF CHANNEL LEVEL switch to middle position. c. Set sweep oscillator for narrowest possible sweep and output level for about 20 mV peak-to-peak at 8407A input. d. Set 8407A 10 dB/step DISPLAY REFERENCE switch to top position. Set DISPLAY REFERENCE CAL thumbwheel for 0 dB. e. Set 8412A MODE switch to AMPL and AMPL dB/DIV to 10. f. Adjust 8407A 1 dB/step DISPLAY REFERENCE switch and amplitude vernier for amplitude trace across top graticule line of 8412A display. If 8412A input signal level is set too high initially, excessive phase error will occur when signal level is decreased. g. Set 8412A BW (kHz) switch to 0.1 and MODE switch to PHASE. h. Adjust 8412A PHASE OFFSET and 8407A PHASE VERNIER controls for a center screen phase trace on the 1 degree/division range. NOTE Although the 8412A phase error cannot be accurately measured independent of the phase error contributed by the Model 8407A, a qualitative indication can be obtained as follows: (1) Connect a dual trace oscilloscope to the 8407A rear-panel IF REF and IF TEST outputs.

Table 5-3. Performance Test with 8407A Mainframe (Sheet 6 of 6)

STEP	DESCRIPTION AND PROCEDURE
8. (Contd)	(2) Adjust oscilloscope and 8407A PHASE VERNIER control to superimpose one waveform on the other. Expand one cycle of trace so that the zero degree point on the sine wave is at the left edge, the 180 degree point is at the center, and the 360° point is at the right edge of the graticule (Figure 5-1a, Waveform A). (With an oscilloscope having 10 cm graticule width, each cm is 36 degrees.) Expand the oscilloscope waveform horizontally by a factor of ten so that each cm represents 3.6 degrees. Adjust oscilloscope to position the center of the waveform on the screen (Figure 5-1a, Waveform B). (3) Observe the oscilloscope display as the 8407A DISPLAY REFERENCE switch is changed. Any phase shift observed on the oscilloscope is due to 8407A phase error. On low level test channel signals the oscilloscope display approaches a horizontal line; however, a small ringing appears on the test channel waveform. This ringing can be observed for horizontal movement down to the last two 8407A DISPLAY REFERENCE switch positions. i. Change the 8407A DISPLAY REFERENCE switch from 0 to 80 dB. The 8412A phase indication should not vary more than 1.0 degree/10 dB step or more than 4 degrees over the upper 70 dB amplitude range. The phase indication should not vary more than 6 degrees over the full 80 dB amplitude range. j. To measure that part of the error contributed by the 8407A phase change with amplitude change, use the following procedure. k. Connect equipment as shown in Figure 5-1. Connect the Reference channel input to the 8407A REF CHANNEL ATTEN input. Connect the step attenuator between the power splitter and the 8407A TEST CHANNEL DIRECT input. Set the 0-120 dB attenuator to 80 dB. Set the 8407A REF CHAN LEVEL ADJ switch to the middle position. l. Set the 8407A DISPLAY REFERENCE 10 dB/step switch to the top position and adjust the DISPLAY REFERENCE CAL thumbwheel for 0. m. Set the sweep oscillator for minimum sweep width at any frequency in the 8407A operating range. Adjust RF output level for maximum power out or until the 8407A REF CHAN LEVEL meter indication is slightly above the operate region, whichever comes first. n. Adjust the display unit PHASE OFFSET and 8407A PHASE VERNIER for a zero degree phase reference on the display unit. o. Check each DISPLAY REFERENCE 10 dB step as follows: (1) Set the DISPLAY REFERENCE 10 dB/step switch one position down. (2) Observe the phase shift indication of the display unit and record. (3) Increase the test channel input power by 10 dB by removing 10 dB from the step attenuator at the test channel input. Adjust the PHASE VERNIER for a zero degree phase indication. (4) Repeat the above steps to check the remaining 10 dB/step positions. Readings recorded are phase changes with amplitude change of the 8407A. NOTE The 8407A REDUCE INPUT RATIO light may come on at high test channel input levels. If so, reduce the sweep oscillator output power to extinguish the light.



Waveform A

Oscilloscope trace of one 278 kHz sine-wave cycle showing in-phase condition with channel A superimposed on channel B. (Horizontal scale is 36 degrees/cm

Waveform B

Trace A expanded horizontally and vertically x 10. (Horizontal scale is 3.6 degrees/cm.)

Figure 5-1a. Oscilloscope Display of In-phase IF Outputs.

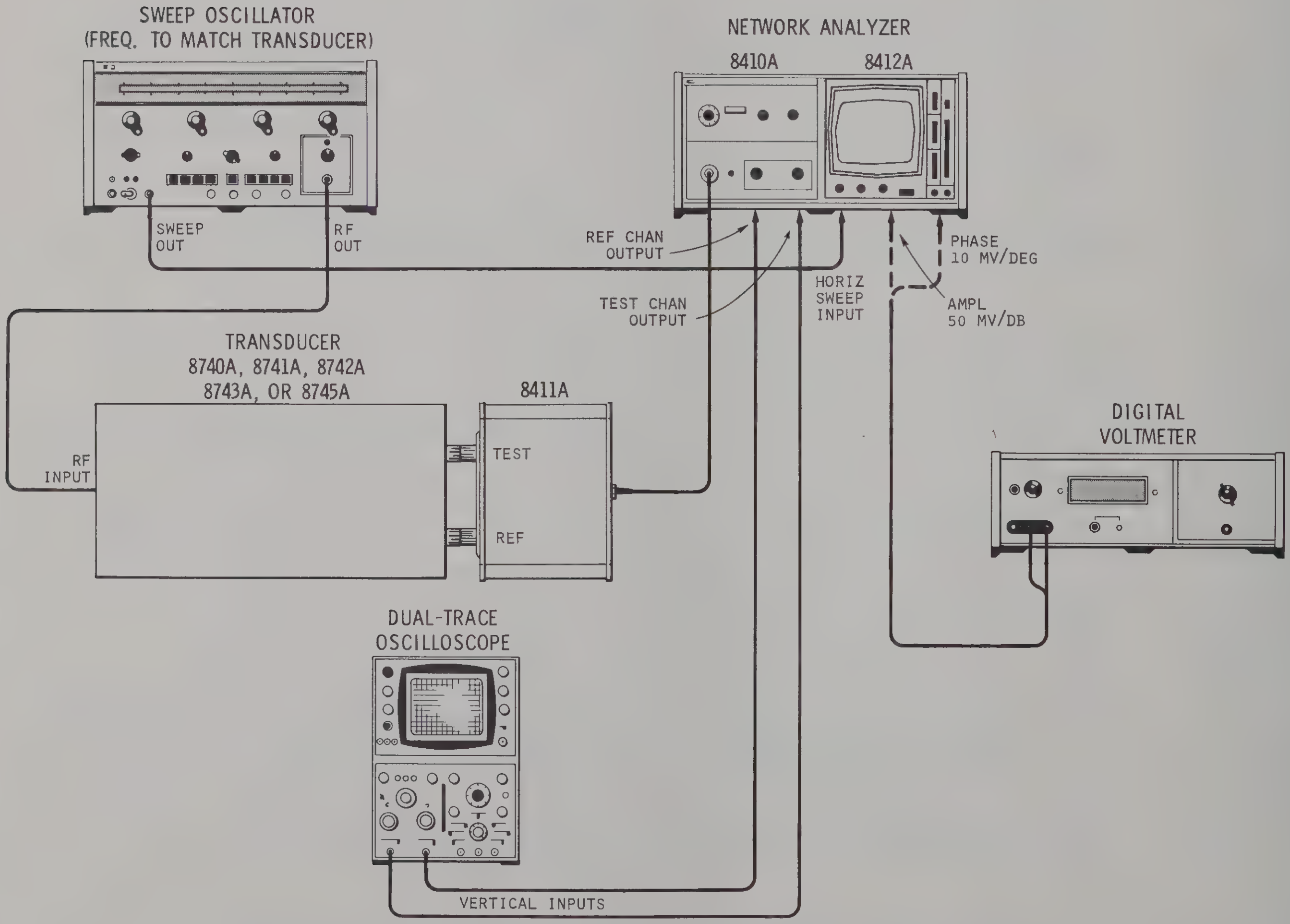


Figure 5-2. Equipment Setup for Performance Test with 8410A Mainframe

Table 5-4. Performance Test with 8410A Mainframe (Sheet 1 of 5)

STEP	DESCRIPTION AND PROCEDURE
1.	INTIAL SETUP SPECIFICATIONS: General operation. DESCRIPTION: Set up and adjust instrument for amplitude and phase trace on CRT. PROCEDURE: a. Connect equipment as shown in Figure 5-2. Set sweep oscillator for swept mode over the narrowest band possible. Set the 8410A AMPL VERNIER to midrange. Adjust 8410A SWEEP STABILITY control and sweep oscillator RF output for REF CHANNEL meter indication in the middle of the OPERATE range. b. While observing oscilloscope, adjust 8410A AMPLITUDE TEST CHANNEL GAIN to obtain 316 mV p-p from 8410A TEST CHAN OUTPUT. c. Set 8412A MODE switch to DUAL, AMPL DB/DIV switch to 10, PHASE DEG/DIV switch to 90, PHASE switch to (+), DEGREES switch to 100, and BW (KHz) switch to 10. Set 8410A AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB. Both amplitude and phase traces should be displayed across 8412A CRT. If necessary, adjust transducer REFERENCE PLANE EXTENSION to obtain horizontal phase trace. Adjust 8412A FOCUS control and both traces should be in good focus. The amplitude trace should be brighter than the phase trace.
2.	TRACE ALIGN SPECIFICATIONS: General operation. DESCRIPTION: Check that CRT circuits are properly aligned by adjusting trace to superimpose center graticule line. PROCEDURE: Set 8412A MODE switch to AMPL. Adjust 8410A AMPL VERNIER control to superimpose the amplitude trace over the center horizontal graticule. The trace should align with the graticule within 1 mm of the trace.
3.	AMPLITUDE TEST SPECIFICATIONS: ±.03 dB/dB and ±.05 division/division; auxiliary outputs ±.03 dB/dB. DESCRIPTION: The accuracy of the rear panel output is checked then the CRT trace is checked through the 60 dB amplitude range. All of the amplitude resolution ranges are then checked for calibration. PROCEDURE: a. Connect digital voltmeter (DVM) to 8412A AMPL 50 mV/dB rear-panel output. Set signal source for single-frequency CW operation. Adjust 8410A AMPL VERNIER control for 0.000 Vdc on DVM. Check DVM readout at AMPLITUDE TEST CHANNEL GAIN control settings listed in table on following page. If necessary, adjust 8412A front panel AMPL CAL (LOW LEVEL) control at zero and 10 dB positions of 8410A AMPLITUDE TEST CHANNEL GAIN control for DVM indication within tolerance.

Table 5-4. Performance Test with 8410A Mainframe (Sheet 2 of 5)

STEP	DESCRIPTION AND PROCEDURE
3. (Contd)	

8410A Amplitude Test Channel Gain*	Digital Voltmeter Reading
60	+2.000 ± .060
50	+1.500 ± .045
40	+1.000 ± .030
30	+0.500 ± .015
20	0.000 ± .005
10	-0.500 ± .015
0	-1.000 ± .030

b. Set sweep oscillator for swept mode over narrowest band possible. Set 8410A AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB. Set MODE switch to AMPL. Adjust 8410 AMPL VERNIER for the trace superimposed on the center graticule line. Check trace position at 8410A AMPLITUDE TEST CHANNEL GAIN 10 dB/step control settings listed in table below. If necessary, adjust 8412A front panel AMPL CAL (LOW LEVEL) control for CRT trace within tolerance at positions of 10 dB and zero dB on 8410A AMPLITUDE TEST CHANNEL GAIN control.

8410A AMPLITUDE TEST CHANNEL GAIN Setting*	Tolerance Of 8412A Trace To Major Graticule Division
60	±0.2 DIV
50	±0.15 DIV
40	±0.1 DIV
30	± .05 DIV
20	± .05 DIV
10	± .05 DIV
0	±0.1 DIV

c. Set 8410A AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB and set 8412A AMPL DB/DIV switch to 2.5. Adjust 8410A AMPL VERNIER for 0.000 Volt indication on DVM. Change 8410A AMPLITUDE TEST CHANNEL GAIN control by + 5 dB. The 8412A dot should move up two major graticule divisions ± 0.5 small graticule division and the DVM should indicate 250 mV ± 10 mV.

d. Set 8412A AMPL DB/DIV switch to 1.0 and set 8410A AMPLITUDE TEST CHANNEL GAIN control to 20 dB.* If necessary, readjust 8410A AMPL VERNIER for 0.000 Volt on DVM. Change 8410A AMPLITUDE TEST CHANNEL GAIN control by + 1 dB. The 8412A dot should move up one major graticule division and the DVM should indicate 50 mV ± 5 mV.

*1 dB/step control set at setting determined in STEP 1b.

Table 5-4. Performance Test with 8410A Mainframe (Sheet 3 of 5)

<table>
<tr><th>STEP</th><th>DESCRIPTION AND PROCEDURE</th></tr>
<tr><td>3.
(Contd)</td><td>e. Set 8412A AMPL DB/DIV switch to 0.25 position. Adjust 8410A AMPL VERNIER control and AMPLITUDE TEST CHANNEL GAIN control to place the amplitude dot on the screen. Change the AMPLITUDE TEST CHANNEL GAIN control by one dB and 8412A dot should move 4 major graticule divisions ± one small division.</td></tr>
<tr><td>4.</td><td>PHASE TEST

SPECIFICATIONS: ±.015 degrees/degree, ±.05 divisions/division; ≤ 3 degrees cumulative; auxiliary output ±.015 degree/degree.

DESCRIPTION: The accuracy of the rear panel output is checked, then the CRT trace is checked through 360 degrees. All of the phase resolution ranges are then checked for calibration.

PROCEDURE:

a. Set sweep oscillator to single-frequency (CW) operation. Connect DVM to PHASE 10 MV/DEG connector at rear panel of 8412A. On 8412A, set MODE switch to PHASE and PHASE DEG/DIV switch to 90. Set 8410A PHASE VERNIER control to mid range and AMPLITUDE TEST CHANNEL GAIN control to 60 dB. Adjust transducer REFERENCE PLANE EXTENSION (line stretcher), 8410A PHASE VERNIER, and sweep oscillator frequency to superimpose the two sine waves on the oscilloscope, showing an in-phase condition at the input of the 8412A.

b. Set 8412A DEGREES control to 180. Set PHASE switch from positive to negative and dot on the 8412A should be erratic, showing a thin vertical line. Adjust 8410A PHASE VERNIER slightly back and forth from in-phase position and observe trace dot become distinct on either side of in-phase condition.

c. Set 8412A DEGREES switch to zero. Make slight adjustment of 8410A PHASE VERNIER for 0.000 Volt DVM indication. Set PHASE switch from positive to negative and DVM should indicate .000 Volt ± .003 Volt in both positions.

d. Set PHASE switch to positive (+) position. Set DEGREES switch to positions shown in table below and obtain DVM indication as shown. Set PHASE switch to negative (-) position and recheck DVM indication at each position of DEGREES switch.

<table>
<tr><th>DEGREES Setting</th><th>DVM Indication</th></tr>
<tr><td>0</td><td>.000 ± .003</td></tr>
<tr><td>20</td><td>0.200 ± .003</td></tr>
<tr><td>40</td><td>0.400 ± .006</td></tr>
<tr><td>60</td><td>0.600 ± .009</td></tr>
<tr><td>80</td><td>0.800 ± .012</td></tr>
<tr><td>100</td><td>1.000 ± .015</td></tr>
<tr><td>120</td><td>1.200 ± .018</td></tr>
<tr><td>140</td><td>1.400 ± .021</td></tr>
<tr><td>160</td><td>1.600 ± .024</td></tr>
</table>

e. Set sweep oscillator for swept mode over narrowest band possible. Set DEGREES switch to each switch position and note the phase trace movement. It should change by two large graticules for 180 degrees offset. (Each small division is 18 degrees.)</td></tr>
</table>

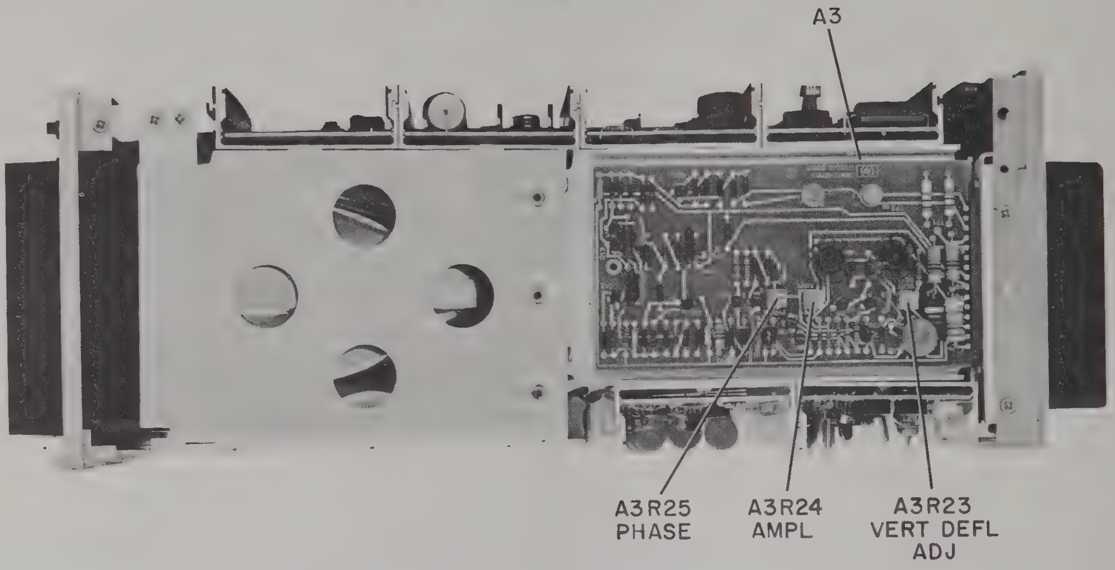
Table 5-4. Performance Test with 8410A Mainframe (Sheet 4 of 5)

STEP	DESCRIPTION AND PROCEDURE
4. (Contd)	f. Set PHASE DEG/DIV switch to 45. Change DEGREES switch by 180 degrees and phase trace should move four large graticule divisions. g. Set PHASE DEG/DIV switch to 10. Change DEGREES switch by 20 degrees and phase trace should move two major graticule divisions. h. Check the 1 DEG/DIV range of the phase circuit by comparing its accuracy to the 5 DEG/DIV range as follows. Set DEGREES switch to zero and PHASE DEG/DIV switch to 10. Adjust the 8410A PHASE VERNIER to place the trace two small graticule lines below the center graticule line. Set PHASE DEG/DIV switch to 1 and trace should move to the bottom graticule line.
5.	BANDWIDTH SWITCH TEST SPECIFICATIONS: General operation. DESCRIPTION: The change in frequency response is observed on the CRT trace when a low-pass filter is connected in both channels. PROCEDURE: Set sweep oscillator for swept mode over narrowest band possible. Set 8410A AMPLITUDE TEST CHANNEL GAIN control to 20 dB. Set 8412A MODE switch to DUAL, AMPL DB/DIV switch to 0.25, PHASE DEG/DIV to 1.0, PHASE polarity switch to positive (+), DEGREES switch to zero, and BW (KHz) switch to 10. Adjust 8410A AMPL VERNIER to place amplitude trace on screen. Both phase and amplitude traces should be on 8412A CRT and both traces should be jagged, showing normal noise on test channel. Set BW (KHz) switch to 0.1 and the traces should change to a continuous smooth trace due to the low-pass filter connected across the amplifier inputs.
6.	BLANKING TEST SPECIFICATIONS: General operation. DESCRIPTION: A voltage simulating a blanking pulse is applied to the rear-panel blanking input and the CRT trace should blank. PROCEDURE: Connect a -4 Vdc supply to 8412A rear-panel BLANKING connector and -4 Vdc return to ground. The traces should be blanked. Disconnect -4 Vdc supply.
7.	Z-AXIS MODULATION TEST SPECIFICATIONS: General operation. DESCRIPTION: Voltages simulating marker or blanking pulses are applied to the rear-panel Z-AXIS input and the CRT trace intensifies or blanks. PROCEDURE: a. Connect a -5 Vdc supply to 8412A rear-panel Z-AXIS connector and -5 Vdc return to ground. The traces should intensify. b. Connect +5 Vdc to 8412A rear-panel Z-AXIS connector and +5 Vdc return to ground. The traces should blank.

Table 5-4. Performance Test with 8410A Mainframe (Sheet 5 of 5)

STEP	DESCRIPTION AND PROCEDURE
8.	PHASE CHANGE DUE TO AMPLITUDE CHANGE SPECIFICATIONS: Over upper 70 dB amplitude range: ≤ 1°/10 dB, maximum phase change not to exceed 4°. Over full 80 dB amplitude range: Maximum phase change not to exceed 6°. DESCRIPTION: The phase trace is observed for change while the signal amplitude in the test channel is changed through the 69 dB range of the 8410A. NOTE When using the 8410A the full 80 dB range of the 8412A cannot be checked. PROCEDURE: a. Set sweep oscillator for single-frequency (CW) operation. Set PHASE DEG/DIV switch to 1 position. Set 8410A TEST CHANNEL GAIN controls for an on-screen amplitude display. Set PHASE polarity and DEGREES switches and 8410A PHASE VERNIER control to place the phase dot near the middle CRT graticule line. b. Adjust the 8410A TEST CHANNEL GAIN controls to zero dB. The difference between maximum and minimum positions of the phase dot trace should not be more than 4 degrees through the 69 dB amplitude range of the 8410A.

LEFT SIDE VIEW



RIGHT SIDE VIEW

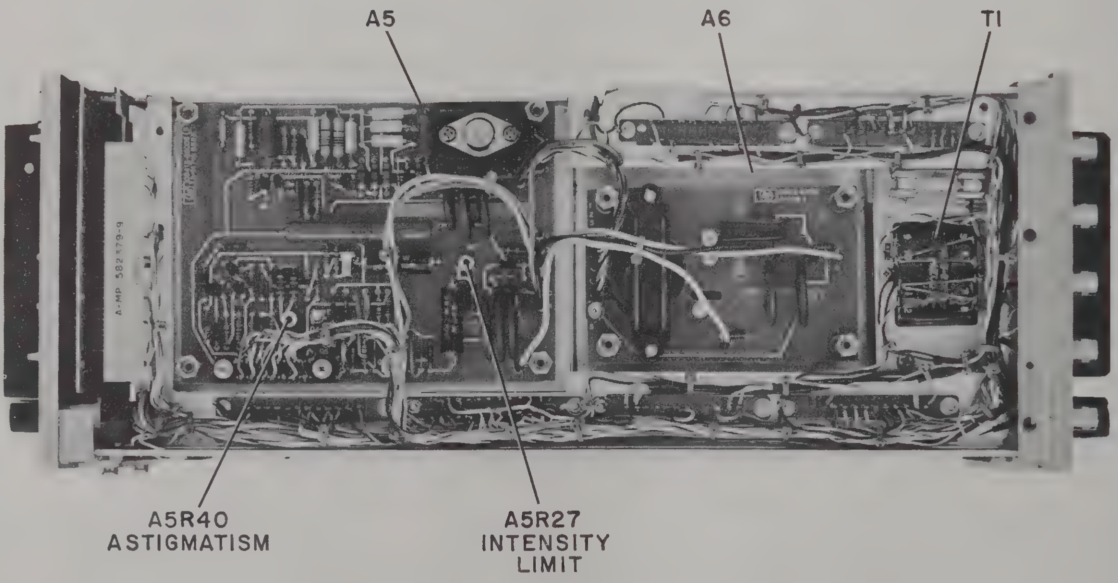
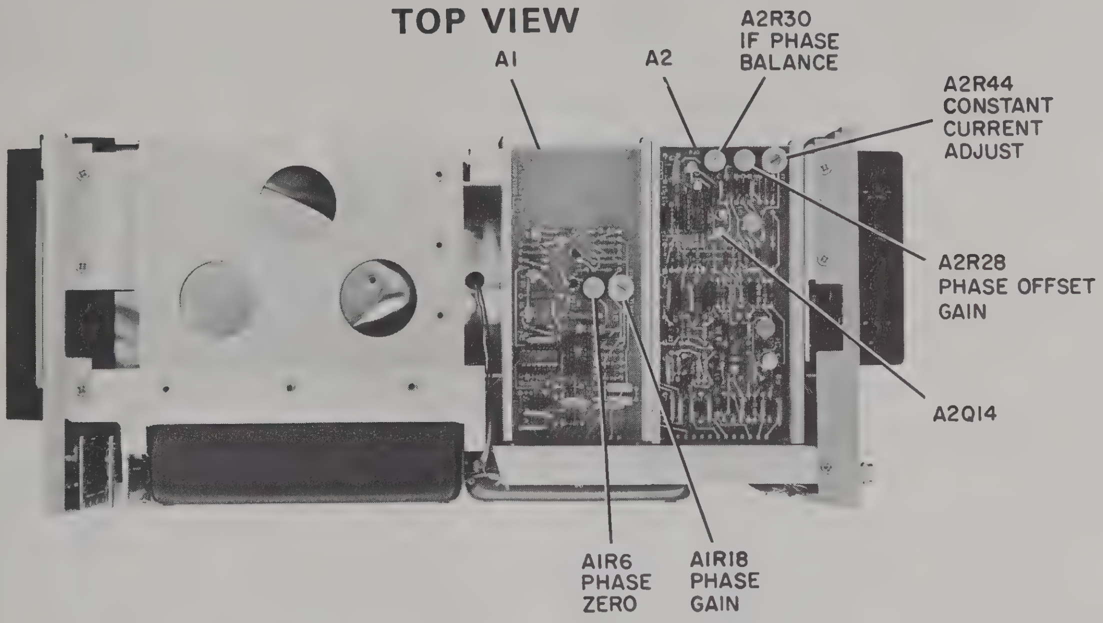


Figure 5-3. Alignment Control Locations (Sheet 1 of 2)


TOP VIEW

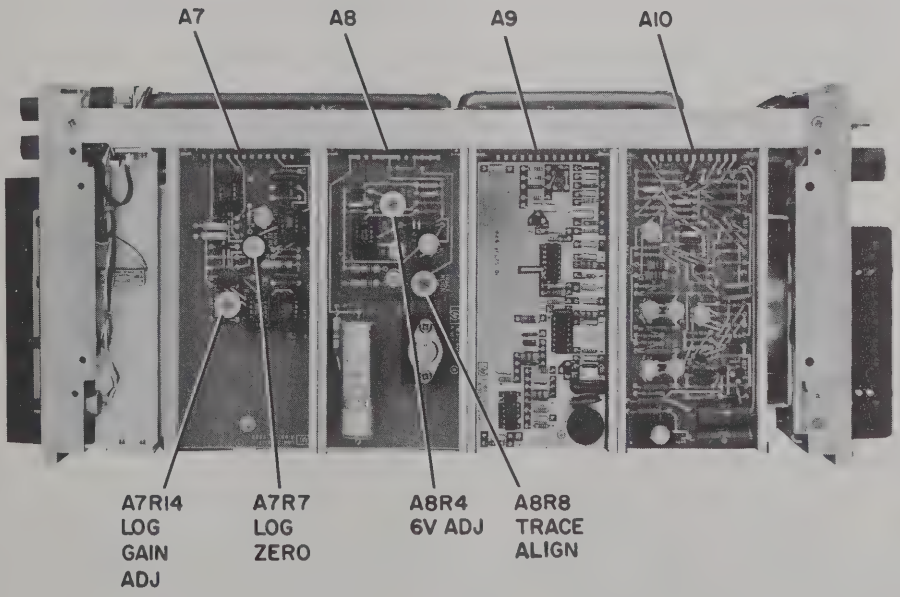

BOTTOM VIEW

Figure 5-3. Alignment Control Locations (Sheet 2 of 2)

Table 5-5. Alignment Controls

Reference Desig.	Name	Function	Performance Step		Alignment Step	
			8407A Table 5-3	8410A Table 5-4	8407A Table 5-6	8410A Table 5-7
A1R6	Phase Zero	Phase offset calibration at zero degrees with in-phase input signals.	4-c	4-c	6-e	6-e
A1R18	Phase Gain	Calibrates phase readout and auxiliary output from phase detector.	4-d	4-d	6-f	6-f
A2R30	IF Phase Balance	Adjusts phase offset calibration to correspond with input phase.	4-b	4-b	6-d	6-d
A2R28	Phase Offset Gain	Adjusts for 20 degrees between each offset step.	4-d	4-d	6-c	6-c
A2R44	Constant Current Adjust	Adjusts for sufficient constant current to reset monostable multivibrator at each input cycle.	4-d	4-d	6-b	6-b
A2R23	VERT DEFL ADJ	Adjusts gain of vertical amplifier for proper display calibration.	3-b thru 3-e, 4-e thru 4-h	3-b thru 3-e, 4-e thru 4-h	5-c thru 5-e, 6-h thru 6-j	5-c thru 5-3, 6-h thru 6-j
A3R24	AMPL	Zeroes the amplitude trace vertically.	3-b thru 3-e	3-b thru 3-e	5-b	5-b
A3R25	PHASE	Zeroes the phase trace vertically.	4-e	4-e	6-g	6-g
A5R27	Intensity Limit	Adjusts range of front-panel intensity control.	1-c	1-c	7	7
A5R40	Astigmatism	Adjust trace astigmatism and works with front panel focus control.	1-c	1-c	4	4
A7R7	Log Zero	Calibrates logging circuit at zero volts on auxillary output.	3-a thru 3-e	3-a thru 3-e	5-a	5-a
A7R14	Log Gain	Calibrates the post-log circuit.	3-a thru 3-e	3-a thru 3-e	5-a	5-a
A8R4	+6V Adjust	Calibrates + and -6 Volt supply.	3-a thru 3-e	3-a thru 3-e	2	2
A8R8	Trace Align	Adjusts CRT field to align the trace to the CRT graticule.	2	2	3	3
R9	Trace Align	Adjusts CRT field to align the trace to the CRT graticule.	2	2	3	3

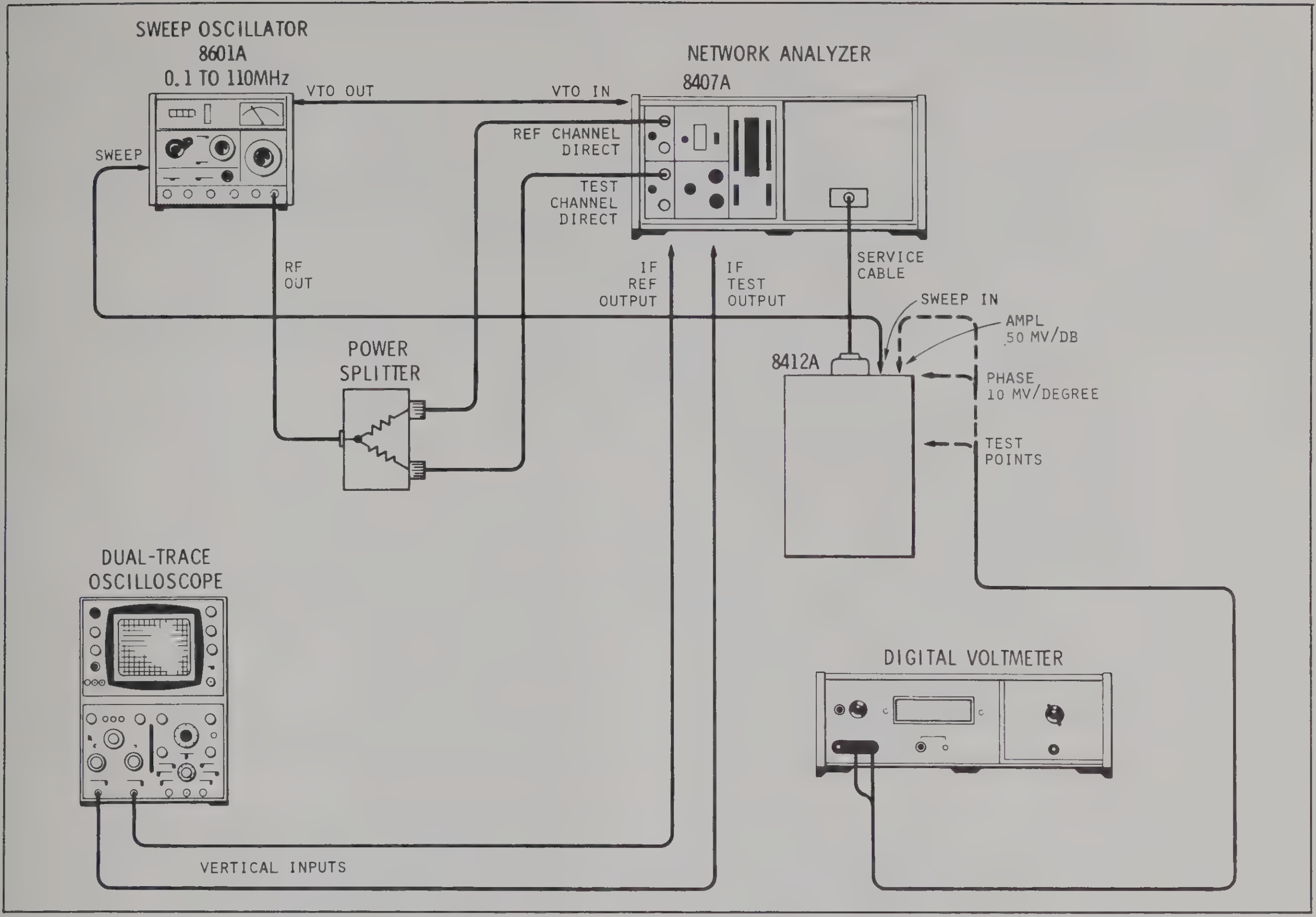


Figure 5-4. Equipment Setup for Alignment Procedures with 8407A Mainframe

Table 5-6. Alignment with 8407A Mainframe (Sheet 1 of 5)

STEP	DESCRIPTION AND PROCEDURE
	WARNING Voltages greater than 1000 Volts are present at the CRT and in assemblies A5 and A6. These voltages could cause injury to personnel.
1.	INITIAL SETUP DESCRIPTION: Setup and adjust instrument for amplitude and phase trace on CRT. PROCEDURE: a. Connect equipment as shown in Figure 5-4. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set the 8407A AMPL VERNIER to midrange and both DISPLAY REFERENCE switches to top position. Set DISPLAY REFERENCE CAL so that zero dB is at the top on both scales. Set 8407A REF CHAN LEVEL ADS switch to the middle position. Adjust sweep oscillator RF output for REF CHANNEL LEVEL meter indication at the top of the OPERATE range.

Table 5-6. Alignment with 8407A Mainframe (Sheet 2 of 5)

STEP	DESCRIPTION AND PROCEDURE
1. (Contd)	b. While observing the oscilloscope, adjust 8407A DISPLAY REFERENCE 1dB/step switch and AMPL VERNIER control to obtain 316 mV p-p from 8407A IF TEST output. It may be necessary to slightly readjust Sweep Oscillator RF output to obtain desired result. Set DISPLAY REFERENCE CAL so that zero dB appears in the 1dB/step scale. c. Set 8412A MODE switch to DUAL, AMPL DB/DIV switch to 10, PHASE DEG/DIV switch to 90, PHASE switch to + (up), DEGREES switch to 100, and BW (kHz) switch to 10. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB. Both amplitude and phase traces should be displayed on 8412A CRT.
2.	POWER SUPPLY (A8R4) DESCRIPTION: The ±6 Volt power supplies are adjusted for correct output. PROCEDURE: Check for +6 Vdc ±0.03 Vdc at A8TP1 and -6 Vdc ±0.03 Vdc at A8TP3. If either is out of tolerance, adjust A8R4 and recheck both test points again.
3.	TRACE ALIGN (A8R8) DESCRIPTION: The voltage to the CRT trace-align coil is adjusted to align trace to graticule on CRT face. PROCEDURE: Set Sweep Oscillator for minimum sweep width. Set 8412A MODE switch to AMPL. Adjust 8407A AMPL VERNIER control and DISPLAY REFERENCE 1 dB/step switch to superimpose the amplitude trace over the center horizontal graticule. For instruments with rear-panel TRACE ALIGN control R9, center rear-panel control and adjust A8R8 TRACE ALIGN control for best alignment of trace to graticule. For instruments without rear-panel TRACE ALIGN control, adjust A8R8 for best alignment of trace to graticule. If trace alignment is not correct when 8412A is installed directly into mainframe, readjust TRACE ALIGN control.
4.	ASTIGMATISM (A5R40) DESCRIPTION: The CRT trace is adjusted for best focus. PROCEDURE: Set sweep oscillator to single-frequency (CW) mode. Adjust ASTIGMATISM control A5R40 and front panel FOCUS control for the smallest dot trace on screen.
5.	AMPLITUDE CALIBRATION (A3R23, A3R24, A7R7, A7R14, AND AMPL. CAL. R4) DESCRIPTION: The CRT trace is adjusted for best focus. PROCEDURE: a. Connect digital voltmeter (DVM) to rear-panel AMPL 50 MV/DB connector. Set 8412A MODE switch to AMPL and AMPL DB/DIV control to 10. Set 8407A DISPLAY REFERENCE control to +40 dB and adjust AMPL VERNIER control for 0.000 Vdc on DVM. If zero Vdc cannot be obtained, adjust A7R7. Check DVM readout at DISPLAY REFERENCE control settings listed in following table. Make alignment adjustments listed in table as necessary.

Table 5-6. Alignment with 8407A Mainframe (Sheet 3 of 5)

STEP	DESCRIPTION AND PROCEDURE
5. (Contd)	

8407A DISPLAY REFERENCE (Zero at top)	Voltmeter Reading	Adjustment
0	+2.000 ± .040	LOG GAIN A7R14
+10	+1.500 ± .030	LOG GAIN A7R14
+20	+1.000 ± .020	LOG GAIN A7R14
+30	+0.500 ± .010	LOG GAIN A7R14
+40	0.000 ± .005	LOG ZERO A7R7
+50	-0.500 ± .010	AMPL CAL - LOW LEVEL (Front Panel)
+60	-1.000 ± .020	AMPL CAL - LOW LEVEL (Front Panel)
+70	-1.500 ± .030	AMPL CAL - LOW LEVEL (Front Panel)
+80	-2.000 ± .040	AMPL CAL - LOW LEVEL (Front Panel)

b. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set the 8407A DISPLAY REFERENCE control to +40 dB and readjust AMPL VERNIER, if necessary, to get a 0.000 Volt indication on the DVM. For instruments with rear-panel VERT POS control, center the VERT POS control. The trace on the 8412A should be on the center horizontal graticule. If not, adjust A3R24 AMPL control. Check vertical deflection amplifier dc balance by moving the 8412A AMPL DB/DIV switch through its full range. If trace moves from center graticule line, readjust 8407A AMPL VERNIER for 0.000 Volt indication on DVM. Readjust A3R24 AMPL control slightly to obtain minimum change in trace deflection with change in vertical sensitivity (AMPL DB/DIV). Set the 8412A AMPL DB/DIV switch to 10 and change the 8407A DISPLAY REFERENCE control in 10 dB steps. The 8412A trace should move one major division for each step. If not, adjust A3R23 and front panel AMPL CAL (LOW LEVEL) controls.

c. Set the 8407A DISPLAY REFERENCE switches to + 40 dB and set 8412A AMPL DB/DIV switch to 2.5. Adjust 8407A AMPL VERNIER for 0.000 Volt indication on DVM. Change 8407A DISPLAY REFERENCE controls to +35 dB. The 8412A trace should move up two major divisions. If not, make slight adjustment of A3R23.

d. Set 8412A AMPL DB/DIV switch to 1.0 and 8407A DISPLAY REFERENCE controls to +40 dB. If necessary, readjust 8407A AMPL VERNIER for 0.000 Volt on DVM. Change 8407A DISPLAY REFERENCE controls to +39 dB. The 8412A trace should move up one major division. If not, make slight adjustment of A3R23.

e. Set 8412A AMPL DB/DIV switch to 0.25 position. Adjust 8407A AMPL VERNIER control and DISPLAY REFERENCE controls to place the amplitude trace on the screen. Change the DISPLAY REFERENCE control by one dB and trace should move 4 major divisions. If not, make slight adjustment of A3R23. If adjustment of A3R23 was necessary in steps c, d, or e, recheck steps b through e again.

Table 5-6. Alignment with 8407A Mainframe (Sheet 4 of 5)

STEP	DESCRIPTION AND PROCEDURE
6.	PHASE CALIBRATION (A1R6, A1R18, A2R30, A2R44, A3R25) DESCRIPTION: The phase offset circuits are adjusted for correct calibration and the phase detector is calibrated. The deflection amplifier is then checked by observing trace deflection on CRT. PROCEDURE: a. Set sweep oscillator for symmetrical sweep operation (minimum sweep width). Connect DVM to PHASE 10 mV/DEG connector at 8412A rear. On 8412A, set MODE to PHASE, PHASE DB/DIV to 90, PHASE OFFSET to (-), and DEGREES switch to 0. Set Network Analyzer PHASE VERNIER to midrange. b. Connect dual trace oscilloscope to the 8407A rear-panel IF REF and IF TEST outputs. c. Adjust Network Analyzer PHASE VERNIER, DISPLAY REFERENCE and oscilloscope to display one sine wave superimposed on the other. Expand one cycle of trace so that the zero degree point on the sine wave is at the left edge and the 360 degree point is at the right edge of the graticule (Figure 5-1a, Waveform A). (With an oscilloscope having 10 cm graticule width, each cm is 36 degrees.) Expand the oscilloscope waveform horizontally by a factor of ten so that each cm represents 3.6 degrees. Adjust oscilloscope to position the center of the waveform on the screen (Figure 5-1a, Waveform B). d. Adjust 8412A A1R6 PHASE ZERO for DVM reading of 0 ±1.5 mVdc. e. Short current source (short A2Q14 base to emitter) and adjust A2R44 for -297 ±2 mVdc. f. Remove short and adjust A1R6, if necessary for 0 ±3 mVdc. g. Adjust A3R25 PHASE control for center graticule line on 8412A. Check vertical deflection amplifier dc balance by moving the 8412A PHASE DEG/DIV switch through its full range. If trace moves from center graticule line, readjust 8412A A1R6 for 0 ±3 mVdc indication on DVM. Readjust A3R25 PHASE control to obtain minimum change in trace deflection with change in vertical sensitivity (PHASE DEG/DIV). Set 8412A PHASE DEG/DIV switch to 90. h. Adjust A2R28 so that maximum difference in DVM reading is 1 mVdc when switching from (+) to (-) PHASE positions. i. Adjust Network Analyzer for 0 ±1 mVdc DVM reading. j. Set 8412A DEGREES switch to 160 and adjust A1R18 so that highest DVM reading for either polarity (+) or (-) is 1.600V ±1 mVdc. k. Set 8412A BW (kHz) switch to 0.1 and DEGREES switch to 180. Adjust A2R30 so that CRT line display stays within 1 cm of center line for either polarity (+) or (-) setting of 8412A. l. Set 8412A DEGREES switch to 0 and adjust A1R6, if necessary, for 0 ±2 mVdc DVM reading.

Table 5-6. Alignment with 8407A Mainframe (Sheet 5 of 5)

STEP	DESCRIPTION AND PROCEDURE
6. (Contd)	m. Set PHASE switch to positive (up). Set DEGREES switch and obtain DVM indication as shown in table below. If not, adjust A1R18. Set PHASE switch to negative and recheck DVM indication at each position of DEGREES switch. Readjust A1R18, if necessary.

DEGREES Setting	DVM Indication
0	0.000 ± .002
20	0.200 ± .003
40	0.400 ± .004
60	0.600 ± .005
80	0.800 ± .006
100	1.000 ± .007
120	1.200 ± .008
140	1.400 ± .009

STEP	DESCRIPTION AND PROCEDURE
7.	INTENSITY LIMIT (A5R27) DESCRIPTION: The range of the front panel INTENSITY control is adjusted so that fully counterclockwise turns trace off and clockwise turns trace to full brightness. PROCEDURE: Adjust front-panel INTENSITY control fully counterclockwise and traces on 8412A should disappear near the counterclockwise position and maximum brightness of trace at fully clockwise position.

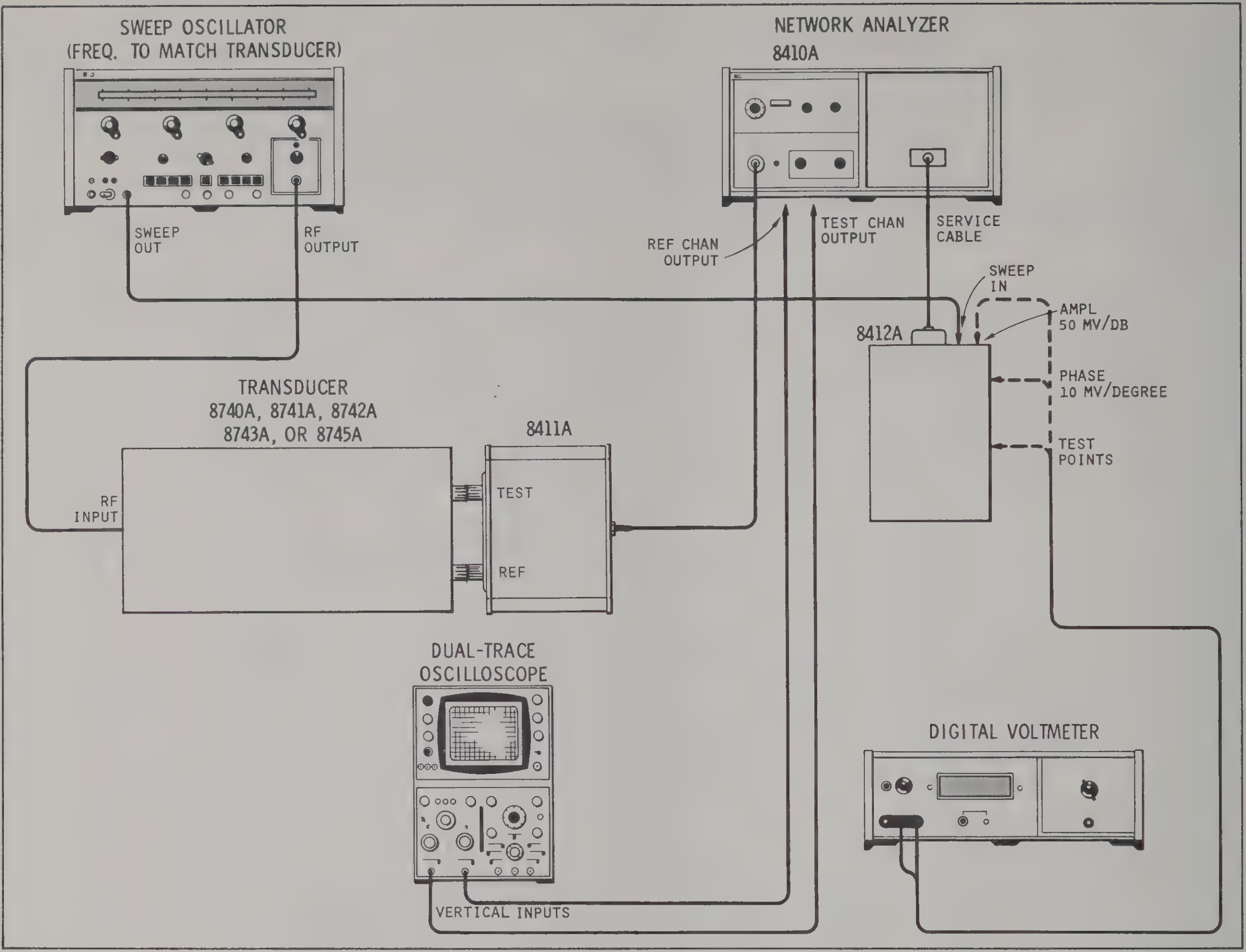


Figure 5-5. Equipment Setup for Alignment Procedures with 8410A Mainframe

Table 5-7. Alignment with 8410A Mainframe (Sheet 1 of 5)

STEP	DESCRIPTION AND PROCEDURE
	WARNING Voltages greater than 1000 Volts are present at the CRT and in assemblies A5 and A6. These voltages could cause injury to personnel.
1.	INITIAL SETUP DESCRIPTION: Setup and adjust instrument for amplitude and phase trace on CRT. PROCEDURE: a. Connect equipment as shown in Figure 5-5. Set sweep oscillator for swept mode over as narrow a band as possible. Adjust 8410A SWEEP STABILITY control and sweep oscillator RF output for RF CHANNEL LEVEL meter indication in the middle of the OPERATE range.

Table 5-7. Alignment with 8410A Mainframe (Sheet 2 of 5)

STEP	DESCRIPTION AND PROCEDURE
1. (Contd)	b. While observing the oscilloscope, adjust 8410A AMPLITUDE TEST CHANNEL GAIN to obtain 316 mV p-p from 8410A TEST CHAN OUTPUT. The setting in the TEST CHANNEL GAIN 1 dB/step window necessary to obtain 316 mV p-p must be used for the AMPLITUDE CALIBRATION PROCEDURE, STEP 5 of this procedure (Table 5-7). c. Set 8412A MODE switch to DUAL, AMPL DB/DIV switch to 10, PHASE DEG/DIV switch to 90, PHASE switch to positive (+), DEGREES switch to 100, and BW (kHz) switch to 10. Set 8410A AMPLITUDE TEST CHANNEL GAIN 10 dB/step (leave 1 dB/Step control at setting determined in STEP 1b). Both amplitude and phase traces should be displayed on 8412A CRT.
2.	POWER SUPPLY (A8R4) DESCRIPTION: The ±6 Volt power supplies are adjusted for correct output. PROCEDURE: Check for +6 Vdc ±0.03 Vdc at A8TP2 and -6 Vdc ±0.03 Vdc at A8TP3. If either is out of tolerance, adjust A8R4 and recheck both test points again.
3.	TRACE ALIGN (A8R8) DESCRIPTION: The voltage to the CRT trace-align coil is adjusted to align trace to graticule on CRT face. PROCEDURE: Set Sweep Oscillator for minimum sweep width. Set 8412A MODE switch to AMPL. Adjust 8410A AMPL VERNIER control to superimpose the amplitude trace over the center horizontal graticule. For instruments with rear-panel TRACE ALIGN control R9, center rear-panel control and adjust A8R8 TRACE ALIGN control for best alignment of trace to graticule. For instruments without rear-panel TRACE ALIGN control adjust A8R8 for best alignment of trace to graticule. If trace alignment is not correct when 8412A is installed directly into mainframe, readjust TRACE ALIGN control.
4.	ASTIGMATISM (A5R40) DESCRIPTION: The CRT trace is adjusted for best focus. PROCEDURE: Set sweep oscillator to single-frequency (CW) mode. Adjust ASTIGMATISM control A5R40 and front panel FOCUS control for the smallest dot trace on screen.
5.	AMPLITUDE CALIBRATION (A3R23, A3R243, A7R7, A7R14, AND AMPL. CAL. R4) DESCRIPTION: The log converter is adjusted for proper calibration at the rear-panel amplitude auxiliary output over the 60 dB range of 8410A mainframe. The CRT amplitude trace is then adjusted for calibration to CRT graticule.

Table 5-7. Alignment with 8410A Mainframe (Sheet 3 of 5)

STEP	DESCRIPTION AND PROCEDURE
5 (Contd)	PROCEDURE:

NOTE

For all of the following settings of the 8410A AMPLITUDE TEST CHANNEL GAIN control, set only the 10 dB/step control. The 1 dB/step control should remain at setting determined in STEP 1b unless otherwise stated.

a. Connect digital voltmeter (DVM) to rear-panel AMPL 50 MV/DB connector. Set 8412A MODE switch to AMPL and AMPL DB/DIV control to 10. Set 8410A AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB and adjust AMPL VERNIER control for 0.000 Vdc on DVM. If zero Vdc cannot be obtained, adjust A7R7. Check DVM readout at AMPLITUDE TEST CHANNEL GAIN control settings listed in table on following page. Make alignment adjustments listed in table as necessary.

8410A AMPLITUDE TEST CHANNEL GAIN*	Digital Voltmeter Reading	Adjustment
60	+2.000 ± .040	LOG GAIN A7R14
50	+1.500 ± .030	LOG GAIN A7R14
40	+1.000 ± .020	LOG GAIN A7R14
30	+0.500 ± .010	LOG GAIN A7R14
20	0.000 ± .005	LOG ZERO A7R7
10	-0.500 ± .010	AMPL CAL - LOW LEVEL (Front Panel)
0	-1.000 ± .020	AMPL CAL - LOW LEVEL (Front Panel)

*1 dB/step control set at setting determined in STEP 1b.

b. Set sweep oscillator for swept mode over as narrow a band as possible. Set the 8410A AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB and readjust AMPL VERNIER, if necessary, to get a 0.000 Vdc indication on the DVM. For instruments with rear-panel VERT POS control, center the VERT POS control. The trace on the 8412A should be on the center horizontal graticule. If not, adjust A3R24 AMPL control. Check vertical deflection amplifier dc balance by moving the 8412A AMPL DB/DIV switch through its full range. If trace moves from center graticule line, readjust 8410A AMPL VERNIER for 0.000 Volt indication on DVM and readjust A3R24 AMPL control slightly to obtain minimum change in trace deflection with change in vertical sensitivity (AMPL DB/DIV). Set the 8412A AMPL DB/DIV switch to 10 and change the AMPLITUDE TEST CHANNEL GAIN control in 10 dB steps. The 8412A trace should move one major division for each step. If not, adjust A3R23 and front panel AMPL CAL (LOW LEVEL) controls.

Table 5-7. Alignment with 8410A Mainframe (Sheet 4 of 5)

STEP	DESCRIPTION AND PROCEDURE
5. (Contd)	c. Set 8410A AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB and set 8412A AMPL DB/DIV switch to 2.5. Adjust 8410A AMPL VERNIER for 0.000 Volt indication on DVM. Change 8410A AMPLITUDE TEST CHANNEL GAIN control by +5 dB. The 8412A trace should move up two major division. If not, make slight adjustment of A3R23. d. Set 8412A AMPL DB/DIV switch to 1.0 and set 8410A AMPLITUDE TEST CHANNEL GAIN control to 20 dB (1 dB/step control set at setting determined in step 1b). If necessary, readjust 8410A AMPL VERNIER for 0.000 Volt on DVM. Change 8410A AMPLITUDE TEST CHANNEL GAIN control by +1 dB. The 8412A trace should move up one major division. If not, make slight adjustment of A3R23. e. Set 8412A AMPL DB/DIV switch to 0.25 position. Adjust 8410A AMPL VERNIER control and AMPLITUDE TEST CHANNEL GAIN control to place the amplitude trace on the screen. Change the AMPLITUDE TEST CHANNEL GAIN control by one dB and dot should move 4 major divisions. If not, make slight adjustment of A3R23. If A3R23 was adjusted in steps c, d, or e, recheck steps b through e again.
6.	PHASE CALIBRATION (A1R6, A1R18, A2R28, A2R30, A2R44, A3R25, AND VERT. POS. R8) DESCRIPTION: The phase offset circuits are adjusted for correct calibration and the phase detector is calibrated. The deflection amplifier is then checked by observing trace deflection on CRT. PROCEDURE: a. Set sweep oscillator for single-frequency (CW) operation. Connect DVM to PHASE 10 mV/DEG connector at 8412A rear. On 8412A, set MODE to PHASE, PHASE DEG/DIV to 90, PHASE OFFSET to (-), and DEGREES switch to 0. Set Network Analyzer PHASE VERNIER to mid-range. b. Connect dual trace oscilloscope to the 8410 rear-panel TEST CHAN OUTPUT and REF CHAN OUTPUT connectors. c. Adjust Network Analyzer PHASE VERNIER, AMPLITUDE TEST CHANNEL GAIN and oscilloscope to display one sine wave superimposed on the other. Expand one cycle of trace so that the zero degree point on the sine wave is at left edge and the 360° point is at the right edge of the graticule (Figure 5-1a, Waveform A). (With an oscilloscope having 10 cm graticule width, each cm is 36 degrees.) Expand the oscilloscope waveform horizontally by a factor of ten so that each cm represents 3.6 degrees. Adjust oscilloscope to position the center of the waveform on the screen (Figure 5-1a, Waveform B). d. Adjust 8412A A1R6 PHASE ZERO for DVM reading 0 ±1.5 mVdc. e. Short current source (short A2Q14 base to emitter) and adjust A2R44 for -297 ±2 mVdc. f. Remove short and adjust A1R6, if necessary, for 0 ±3 mVdc.

Table 5-7. Alignment with 8410A Mainframe (Sheet 5 of 5)

<table>
<tr><th>STEP</th><th>DESCRIPTION AND PROCEDURE</th></tr>
<tr><td>6.
(Contd)</td><td>
g. Adjust A3R25 for center graticule line on 8412A. Check vertical deflection amplifier dc balance by moving the 8412A PHASE DEG/DIV switch through its full range. If trace moves from center graticule line, readjust 8412A A1R6 for 0 ±3 mVdc indication on DVM. Readjust A3R25 PHASE control to obtain minimum change in trace deflection with change in vertical sensitivity (PHASE DEG/DIV). Set 8412A PHASE DEG/DIV switch to 90.

h. Adjust A2R28 so that maximum difference in DVM reading is 1 mVdc when switching from (+) to (-) PHASE positions.

i. Adjust Network Analyzer for 0 ±1 mVdc DVM reading.

j. Set 8412A DEGREES switch to 160 and adjust A1R18 so that highest DVM reading for either polarity (+) or (-) is 1.600V ±1 mVdc.

k. Set 8412A BW (kHz) switch to 0.1 and DEGREES switch to 180. Adjust A2R30 so that CRT line display stays within 1 cm of center line for either polarity (+) or (-) setting of 8412A.

l. Set 8412A DEGREES switch to 0 and adjust A1R6, if necessary, for 0 ±2 mVdc DVM reading.

m. Set PHASE switch to positive (up). Set DEGREES switch and obtain DVM indication as shown in table below. If not, adjust A1R18. Set PHASE switch to negative and recheck DVM indication at each position of DEGREES switch. Readjust A1R18 if necessary.

<table>
<tr><th>DEGREES Setting</th><th>DVM Indication</th></tr>
<tr><td>0</td><td>0.000 ± .002</td></tr>
<tr><td>20</td><td>0.200 ± .003</td></tr>
<tr><td>40</td><td>0.400 ± .004</td></tr>
<tr><td>60</td><td>0.600 ± .005</td></tr>
<tr><td>80</td><td>0.800 ± .006</td></tr>
<tr><td>100</td><td>1.000 ± .007</td></tr>
<tr><td>120</td><td>1.200 ± .008</td></tr>
<tr><td>140</td><td>1.400 ± .009</td></tr>
<tr><td>160</td><td>1.600 ± .010</td></tr>
</table>
</td></tr>
<tr><td>7.</td><td>
INTENSITY LIMIT (A5R27)

DESCRIPTION: The range of the front panel INTENSITY control is adjusted so that fully counterclockwise turns trace off and clockwise turns trace to full brightness.

PROCEDURE:

Adjust front-panel INTENSITY control fully counterclockwise and traces on 8412A should disappear near the counterclockwise stop. If not, adjust A5R27 for a range of INTENSITY control that gives no trace near counterclockwise position and maximum brightness of trace at fully clockwise position.
</td></tr>
</table>

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1. gives the meanings of the abbreviations and reference designations used in the table of replaceable parts. Table 6-2 lists parts in alphanumerical order of their reference designators and indicates the description and HP stock number of each part, together with any applicable notes. Miscellaneous parts are listed at the end of Table 6-2.

a. Description.

b. Manufacturer of the part in a five-digit code; see list of manufacturers in Table 6-3.

c. Manufacturer's part number.

d. Total quantity used (TQ column).

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see list at rear of this manual for addresses). Identify parts by their Hewlett-Packard stock numbers.

6-5. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

Table 6-1. Reference Designations and Abbreviations Used in the Table of Replaceable Parts.

REFERENCE DESIGNATORS

A = assembly
B = motor
BT = battery
C = capacitor
CP = coupler
CR = diode
DL = delay line
DS = device signaling (lamp)
E = misc electronic part
F = fuse
FL = filter
IC = integrated circuit
J = jack
K = relay
L = inductor
LS = loud speaker
M = meter
MK = microphone
MP = mechanical part
P = plug
Q = transistor
R = resistor
RT = thermistor
S = switch
T = transformer
TB = terminal board
TP = test point
V = vacuum tube, neon bulb, photocell, etc.
VR = voltage regulator
W = cable
X = socket
Y = crystal
Z = tuned cavity, network

ABBREVIATIONS

A = amperes
AFC = automatic frequency control
AMPL = amplifier

BFO = beat frequency oscillator
BE CU = beryllium copper
BH = binder head
BP = bandpass
BRS = brass
BWO = backward wave oscillator

CCW = counter-clockwise
CER = ceramic
CMO = cabinet mount only
COEF = coefficient
COM = common
COMP = composition
COMPL = complete
CONN = connector
CP = cadmium plate
CRT = cathode-ray tube
CW = clockwise

DEPC = deposited carbon
DR = drive

ELECT = electrolytic
ENCAP = encapsulated
EXT = external

F = farads
FH = flat head
FIL H = fillister head
FXD = fixed

G = giga (10^9)
GE = germanium
GL = glass
GRD = ground(ed)

H = henries
HDW = hardware
HEX = hexagonal
HG = mercury
HR = hour(s)
HZ = hertz

IF = intermediate freq
IMPG = impregnated
INCD = incandescent
INCL = include(s)
INS = insulation(ed)
INT = internal

K = kilo = 1000

LH = left hand
LIN = linear taper
LK WASH = lock washer
LOG = logarithmic taper
LPF = low pass filter

M = milli = 10^{-3}
MEG = meg = 10^6
MET FLM = metal film
MET OX = metallic oxide
MFR = manufacturer
MHZ = mega hertz
MINAT = miniature
MOM = momentary
MTG = mounting
MY = "mylar"

N = nano (10^{-9})
N/C = normally closed
NE = neon
NI PL = nickel plate

N/O = normally open
NPO = negative positive zero (zero temperature coefficient)
NPN = negative-positive-negative
NRFR = not recommended for field replacement
NSR = not separately replaceable

OBD = order by description
OH = oval head
OX = oxide

P = peak
PC = printed circuit
PF = picofarads = 10^{-12} farads
PH BRZ = phosphor bronze
PHL = Phillips
PIV = peak inverse voltage
PNP = positive-negative-positive

P/O = part of
POLY = polystyrene
PORC = porcelain
POS = position(s)
POT = potentiometer
PP = peak-to-peak
PT = point
PWV = peak working voltage

RECT = rectifier
RF = radio frequency
RH = round head or right hand

RMO = rack mount only
RMS = root-mean square
RWV = reverse working voltage

S-B = slow-blow
SCR = screw
SE = selenium
SECT = section(s)
SEMICON = semiconductor
SI = silicon
SIL = silver
SL = slide
SPG = spring
SPL = special
SST = stainless steel
SR = split ring
STL = steel

TA = tantalum
TD = time delay
TGL = toggle
THD = thread
TI = titanium
TOL = tolerance
TRIM = trimmer
TWT = traveling wave tube

U = micro = 10^{-6}

VAR = variable
VDCW = dc working volts

W/ = with
W = watts
WIV = working inverse voltage

WW = wirewound
W/O = without

01194-13

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	08412-60001	1	BOARD ASSY:PHASE DETECTOR	28480	08412-60001
A1	08412-60030	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60030
A1C1	0140-0199	1	C:FXD MICA 240 PF 5%	28480	0140-0199
A1C2	0160-2917	15	C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A1C3	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A1C4	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A1C5	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A1C6	0160-0301	2	C:FXD MY 0.012 UF 10% 200VDCW	56289	192P12392-PTS
A1C7	0160-0301		C:FXD MY 0.012 UF 10% 200VDCW	56289	192P12392-PTS
A1C8	0180-0116	9	C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A1C9	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A1C10	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A1CR1	1901-0040	12	DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR2	1902-0686	2	DIODE BREAKDOWN:6.2V 2%	04713	1N825
A1CR3	1902-0686		DIODE BREAKDOWN:6.2V 2%	04713	1N825
A1IC1	1820-0102	1	INTEGRATED CIRCUIT:J-K FLIP FLOP	04713	MC1013P
A1IC2	1826-0007	7	IC:LINEAR (RECOMMENDED REPLACEMENT)	28480	1826-0007
A1L1	9140-0210	9	COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A1L2	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A1L3	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A1L4	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A1L5	9100-1664	3	COIL/CHOKE 3000 UH 5%	28480	9100-1664
A1Q1	1854-0019	4	TSTR:SI NPN	28480	1854-0019
A1Q2	1854-0019		TSTR:SI NPN	28480	1854-0019
A1Q3	1853-0020	8	TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q4	1854-0073	1	TSTR:SI NPN(SELECTED FROM 2N2857)	28480	1854-0073
A1Q5	1854-0023	2	TSTR:SI NPN(SELECTED FROM 2N2484)	28480	1854-0023
A1Q6	1854-0023		TSTR:SI NPN(SELECTED FROM 2N2484)	28480	1854-0023
A1R1	0757-0422	3	R:FXD MET FLM 909 OHM 1% 1/8W	28480	0757-0422
A1R2	0698-0083	4	R:FXD MET FLM 1.96K OHM 1% 1/8W	28480	0698-0083
A1R3	0757-0280	32	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R4	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R5	0757-1094	3	R:FXD MET FLM 1.47K OHM 1% 1/8W	28480	0757-1094
A1R6	2100-1772	1	R:VAR WW 500 OHM 5% TYPE H 1W	28480	2100-1772
A1R7	0757-0401	18	R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R8	0757-0421	1	R:FXD MET FLM 825 OHM 1% 1/8W	28480	0757-0421
A1R9	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R10	0757-0402	2	R:FXD MET FLM 110 OHM 1% 1/8W	28480	0757-0402
A1R11	0757-0428	3	R:FXD MET FLM 1.62K OHM 1% 1/8W	28480	0757-0428
A1R12	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R13	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R14	0698-3152	2	R:FXD MET FLM 3.48K OHM 1% 1/8W	28480	0698-3152
A1R15	0698-3440	14	R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A1R16	0698-3152		R:FXD MET FLM 3.48K OHM 1% 1/8W	28480	0698-3152
A1R17	0698-0082	3	R:FXD MET FLM 464 OHM 1% 1/8W	28480	0698-0082
A1R18	2100-1769	1	R:VAR WW 50 OHM 5% TYPE H 1W	28480	2100-1769
A1R19	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R20	0757-0416	17	R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A1R21	0757-0438	8	R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1R22	0757-0200	3	R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200
A2	08412-60002	1	BOARD ASSY:PHASE OFFSET	28480	08412-60002
A2	08412-60031	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60031
A2C1	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C2	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C3	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C4	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C5	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C6	0180-0291	19	C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A2C7	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C8	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A2C9	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C10	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C11	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C12	0160-2219	1	C:FXD MICA 1100 PF 5%	28480	0160-2219
A2C13	0160-2212	1	C:FXD MICA 560 PF 5% 300VDCW	28480	0160-2212
A2C14	0160-2204	1	C:FXD MICA 100PF 5%	72136	RDM15F101J3C
A2C15	0140-0198	1	C:FXD MICA 200 PF 5%	72136	RDM15F201J3C
A2C16	0180-0197	14	C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C17	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C18	0180-0195	1	C:FXD ELECT 0.33 UF 20% 35VDCW	56289	150D334X0035A2-DYS
A2C19	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C20	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A2C21	0180-1735	2	C:FXD ELECT 0.22 UF 10% 35VDCW	28480	0180-1735
A2C22	0180-1735		C:FXD ELECT 0.22 UF 10% 35VDCW	28480	0180-1735
A2C23	0160-2207	1	C:FXD MICA 300 PF 5%	28480	0160-2207

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2CR1	1910-0016	4	DIODE:GERMANIUM 100MA/0.85V 60PIV	93332	D2361
A2CR2	1910-0016		DIODE:GERMANIUM 100MA/0.85V 60PIV	93332	D2361
A2CR3	1901-0025	4	DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR4	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR5	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR6	1901-0025		DIODE:SILICON 100MA/1V	07263	FD 2387
A2CR7	1910-0016		DIODE:GERMANIUM 100MA/0.85V 60PIV	93332	D2361
A2CR8	1910-0016		DIODE:GERMANIUM 100MA/0.85V 60PIV	93332	D2361
A2IC1	1820-0213	1	IC:ECL DUAL R-S F/F	04713	MC1014P
A2L1	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A2L2	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A2L3	9100-1666	1	COIL/CHOKE:FXD 3600 UH 5%	28480	9100-1666
A2L4	9100-1649	1	COIL/CHOKE 620 UH 5%	28480	9100-1649
A2L5	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A2Q1	1854-0071	27	TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q2	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q4	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q5	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q6	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q7	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q8	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q9	1854-0019		TSTR:SI NPN	28480	1854-0019
A2Q10	1854-0019		TSTR:SI NPN	28480	1854-0019
A2Q11	1854-0295	3	TSTR:SI NPN	28480	1854-0295
A2Q12	1854-0475	5	TSTR:SI NPN(RECOMMENDED REPLACEMENT)	28480	1854-0475
A2Q13	1854-0475		TSTR:SI NPN(RECOMMENDED REPLACEMENT)	28480	1854-0475
A2Q14	1853-0050	4	TSTR:SI PNP	28480	1853-0050
A2Q15	1853-0050		TSTR:SI PNP	28480	1853-0050
A2R1	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R2	0757-0199	3	R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A2R3	0698-0082		R:FXD MET FLM 464 OHM 1% 1/8W	28480	0698-0082
A2R4	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A2R5	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R6	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R7	0698-3157	3	R:FXD MET FLM 19.6K OHM 1% 1/8W	28480	0698-3157
A2R8	0698-3450	6	R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A2R9	0698-3450		R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A2R10	0698-3450		R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A2R11	0698-3450		R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A2R12	0757-0422		R:FXD MET FLM 909 OHM 1% 1/8W	28480	0757-0422
A2R13	0698-3447	2	R:FXD MET FLM 422 OHM 1% 1/8W	28480	0698-3447
A2R14	0698-3447		R:FXD MET FLM 422 OHM 1% 1/8W	28480	0698-3447
A2R15	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R16	0757-0442	13	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R17	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R18	0757-0422		R:FXD MET FLM 909 OHM 1% 1/8W	28480	0757-0422
A2R19	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	28480	0698-0083
A2R20	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	28480	0698-0083
A2R21	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R22	0757-0443	2	R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A2R23	0757-0443		R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A2R24	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R25	0757-1094		R:FXD MET FLM 1.47K OHM 1% 1/8W	28480	0757-1094
A2R26	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R27	0757-0278	1	R:FXD MET FLM 1.78K OHM 1% 1/8W	28480	0757-0278
A2R28	2100-1770	1	R:VAR WW 100 OHM 5% TYPE H 1W	28480	2100-1770
A2R29	0698-6652	1	R:FXD FLM 1.74K OHM 1% 1/8W	28480	0698-6652
A2R30	2100-1773	2	R:VAR WW 1K OHM 5% TYPE H 1W	28480	2100-1773
A2R31	0698-6337	2	R:FXD FLM 1.3K OHM 1% 1/8W	28480	0698-6337
A2R32	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R33	0698-3442	3	R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A2R34	0698-6337		R:FXD FLM 1.3K OHM 1% 1/8W	28480	0698-6337
A2R35	0757-0424	2	R:FXD MET FLM 1.10K OHM 1% 1/8W	28480	0757-0424
A2R36	0757-0399	2	R:FXD MET FLM 82.5 OHM 1% 1/8W	28480	0757-0399
A2R37	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A2R38	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A2R39	0757-0399		R:FXD MET FLM 82.5 OHM 1% 1/8W	28480	0757-0399
A2R40	0698-3157		R:FXD MET FLM 19.6K OHM 1% 1/8W	28480	0698-3157
A2R41	0757-0460	1	R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A2R42	0757-0440	3	R:FXD MET FLM 7.50K OHM 1% 1/8W	28480	0757-0440
A2R43	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A2R44	2100-1777	2	R:VAR WW 20K OHM 5% TYPE H 1W	28480	2100-1777
A2R45	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3	08412-60003	1	BOARD ASSY:MULTIPLEXER/DEFL AMPLIFIERS	28480	08412-60003
A3	08412-60032	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60032
A3C1	0160-2055	3	C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A3C2	0150-0096	8	C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA
A3C3	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A3C4	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A3C5	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A3C6	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A3C7	0160-2930	1	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A3C8	0160-2213	2	C:FXD MICA 620 PF 5% 300VDCW	28480	0160-2213
A3C9	0160-2146	2	C:FXD CER 0.02 UF +80-20% 100VDCW	91418	TA
A3C10	0160-2213		C:FXD MICA 620 PF 5% 300VDCW	28480	0160-2213
A3C11	0160-2146		C:FXD CER 0.02 UF +80-20% 100VDCW	91418	TA
A3C12	0160-0161	5	C:FXD MY 0.01 UF 10% 200VDCW	56289	192P10392-PTS
A3C13	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A3CR1	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR2	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR3	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR4	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR5	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR6	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3L1	9100-1664		COIL/CHOKE 3000 UH 5%	28480	9100-1664
A3L2	9100-1664		COIL/CHOKE 3000 UH 5%	28480	9100-1664
A3L3	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A3Q1	1854-0232	4	TSTR:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232
A3Q1	1205-0050	2	HEAT DISSIPATOR	28480	1205-0050
A3Q2	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q4	1854-0232		TSTR:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232
A3Q4	1205-0050		HEAT DISSIPATOR	28480	1205-0050
A3Q5	1854-0232		TSTR:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232
A3Q6	1854-0232		TSTR:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232
A3Q7	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q8	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q9	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q10	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q11	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A3Q12	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A3Q13	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q14	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q15	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3R1	0698-3646	2	R:FXD MET OX 12K OHM 5% 2W	28480	0698-3646
A3R2	0698-3646		R:FXD MET OX 12K OHM 5% 2W	28480	0698-3646
A3R3	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A3R4	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A3R5	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R6	0698-3443	4	R:FXD MET FLM 287 OHM 1% 1/8W	28480	0698-3443
A3R7	0698-3443		R:FXD MET FLM 287 OHM 1% 1/8W	28480	0698-3443
A3R8	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R9	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R10	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R11	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R12	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R13	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R14	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A3R15	0757-0279	7	R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A3R16	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R17	0757-0459	2	R:FXD MET FLM 56.2K OHM 1% 1/8W	28480	0757-0459
A3R18	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A3R19	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R20	0698-3156	2	R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A3R21	0757-0317	1	R:FXD MET FLM 1.33K OHM 1% 1/8W	28480	0757-0317
A3R22	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A3R23	2100-2515	1	R:VAR CERMET 200K OHM 10% LIN 1/2W	28480	2100-2515
A3R24	2100-2521	2	R:VAR FLM 2000 OHM 10% LIN 1/2W	28480	2100-2521
A3R25	2100-2521		R:VAR FLM 2000 OHM 10% LIN 1/2W	28480	2100-2521
A3R26	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R27	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R28	0698-3443		R:FXD MET FLM 287 OHM 1% 1/8W	28480	0698-3443
A3R29	0698-3443		R:FXD MET FLM 287 OHM 1% 1/8W	28480	0698-3443
A3R30	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R31	0698-3158	2	R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
A3R32	0757-0459		R:FXD MET FLM 56.2K OHM 1% 1/8W	28480	0757-0459
A3R33	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R34	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3R35	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A3R36	0757-0309	2	R:FXD MET FLM 61.9K OHM 1% 1/2W	28480	0757-0309
A3R37	0757-0309		R:FXD MET FLM 61.9K OHM 1% 1/2W	28480	0757-0309
A3R38	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R39	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R40	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R41	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R42	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A3R43	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A3R44	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A3R45	0757-0458	2	R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A3R46	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A3R47	0757-0441	6	R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A3R48	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R49	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R50	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R51	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R52	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A3R53	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A3R54	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A3R55	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A4	08412-60011	1	PHASE OFFSET & FUNCTION SWITCH ASSY	28480	08412-60011
A4	08412-60044	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60044
A4R1	0698-5438	9	R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R2	0698-5438		R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R3	0698-5438		R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R4	0698-5438		R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R5	0698-5438		R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R6	0698-5438		R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R7	0698-5438		R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R8	0698-5438		R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R9	0698-5438		R:FXD FLM 100 OHM 0.25% 1/8W	28480	0698-5438
A4R10	0698-6076	1	R:FXD FLM 39K OHM 1% 1/8W	28480	0698-6076
A4R11	0698-6253	2	R:FXD FLM 9000 OHM 0.5% 1/8W	28480	0698-6253
A4R12	0757-1093	1	R:FXD FLM 3K OHM 1% 1/8W	28480	0757-1093
A4R13			NOT ASSIGNED		
A4R14	0698-7354	1	R:FXD FLM 99K OHM 1% 1/8W	28480	0698-7354
A4R15	0698-6253		R:FXD FLM 9000 OHM 0.5% 1/8W	28480	0698-6253
A4R16	0757-0274	1	R:FXD MET FLM 1.21K OHM 1% 1/8W	28480	0757-0274
A4R17	0757-0402		R:FXD MET FLM 110 OHM 1% 1/8W	28480	0757-0402
A4A1	08412-60012	1	SWITCH BOARD	28480	08412-60012
A4A1	08412-60045	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60045
A4A1	08620-40013	1	CONNECTOR:PC SPACER	28480	08620-40013
A5	08412-60005	1	HIGH VOLTAGE POWER SUPPLY & REGULATOR	28480	08412-60005
A5	08412-60034	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60034
A5C1	0160-0889	1	C:FXD MY 0.33 UF 10% 80VDCW	28480	0160-0889
A5C2	0170-0040	1	C:FXD MY 0.047 UF 10% 200VDCW	56289	192P47392-PTS
A5C3			NOT ASSIGNED		
A5C4			NOT ASSIGNED		
A5C5	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A5C6	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A5C7	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A5C8	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A5C9			NOT ASSIGNED		
A5C10	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A5C11	0160-2236	1	C:FXD CER 1.0 PF 500VDCW	72982	301-000-COKO-109C
A5C12	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A5C13	0160-3460	2	C:FXD CER 0.05 UF +80-20% 100VDCW	56289	C023E101L503ZS22-CDM
A5C14	0160-3460		C:FXD CER 0.05 UF +80-20% 100VDCW	56289	C023E101L503ZS22-CDM
A5C15	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A5C16	0160-3007	4	C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5S0-472M
A5C17	0160-3008	3	C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5S0-472M
A5C18	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5S0-472M
A5C19	0160-3008		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5S0-472M
A5C20	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5S0-472M
A5C21	0160-2403	1	C:FXD CER 1500 PF 20% 5K VDCW	72982	828-025-X5R0-152M
A5CR1	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A5CR2	1902-0049	1	DIODE:BREAKDOWN 6.19V 5%	04713	SZ10939-122
A5CR3	1901-0050	8	DIODE:SI 200 MA AT 1V	07263	FDA 6308
A5CR4	1902-0569	1	DIODE:SILICON 1N941 11.5V 2%	04713	SZ 11489
A5CR5	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A5CR6	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A5CR7	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A5CR8	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A5CR9	1901-0026	1	DIODE:SILICON 0.75A 200PIV	04713	SR1358-8

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5CR10	1901-0033	1	DIODE:SILICON 100MA 180WV	07263	FD3369
A5CR11	1901-0050		DIODE:SI 200 MA AT 1V	07263	FDA 6308
A5CR12	1901-0050		DIODE:SI 200 MA AT 1V	07263	FDA 6308
A5L1	9100-1630	5	COIL/CHOKE 51.0 UH 5%	28480	9100-1630
A5L2	9100-1630		COIL/CHOKE 51.0 UH 5%	28480	9100-1630
A5L3	9100-1630		COIL/CHOKE 51.0 UH 5%	28480	9100-1630
A5L4	9100-1630		COIL/CHOKE 51.0 UH 5%	28480	9100-1630
A5L5	9100-1630		COIL/CHOKE 51.0 UH 5%	28480	9100-1630
A5Q1	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A5Q2	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A5Q3	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A5Q4	1853-0050		TSTR:SI PNP	28480	1853-0050
A5Q5	1853-0050		TSTR:SI PNP	28480	1853-0050
A5Q6	1853-0012	2	TSTR:SI PNP	80131	2N2904A
A5Q7	1854-0022	1	TSTR:SI NPN	07263	S17843
A5Q8	1854-0475		TSTR:SI NPN(RECOMMENDED REPLACEMENT)	28480	1854-0475
A5Q9	1853-0012		TSTR:SI PNP	80131	2N2904A
A5Q10	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A5Q11	1854-0282	1	TSTR:SI NPN	80131	2N3583
A5R1	0757-0424		R:FXD MET FLM 1.10K OHM 1% 1/8W	28480	0757-0424
A5R2	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A5R2			FACTORY SELECTED PART		
A5R3	0757-0466	1	R:FXD MET FLM 110K OHM 1% 1/8W	28480	0757-0466
A5R4	0698-3136	2	R:FXD MET FLM 17.8K OHM 1% 2/8W	19701	MF4C T-0
A5R5	0757-1094		R:FXD MET FLM 1.47K OHM 1% 1/8W	28480	0757-1094
A5R6	0698-3432	1	R:FXD MET FLM 26.1 OHM 1% 1/8W	28480	0698-3432
A5R7	0757-0467	1	R:FXD MET FLM 121K OHM 1% 1/8W	28480	0757-0467
A5R8	0757-0465	1	R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A5R9	0698-0083		R:FXD MET FLM 1.96K OHM 1% 1/8W	28480	0698-0083
A5R10	0698-3338	1	R:FXD MET OX 1500 OHM 5% 2W	28480	0698-3338
A5R11	0698-3158		R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
A5R12	0757-0420	1	R:FXD MET FLM 750 OHM 1% 1/8W	28480	0757-0420
A5R13	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A5R14	0698-3155	4	R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A5R15	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A5R16	0698-3157		R:FXD MET FLM 19.6K OHM 1% 1/8W	28480	0698-3157
A5R17	0757-0200		R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200
A5R18	0757-0200		R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200
A5R19	0698-3435	1	R:FXD MET FLM 38.3 OHM 1% 1/8W	28480	0698-3435
A5R20	0698-0335	1			
A5R21	0698-3450		R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A5R22	0698-3450		R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A5R23	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A5R24	0698-3444	2	R:FXD MET FLM 316 OHM 1% 1/8W	28480	0698-3444
A5R25	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A5R26	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A5R27	2100-1618	1	R:VAR FLM 1 MEGOHM 20% LIN 1/2W	28480	2100-1618
A5R28	0836-0003	2	R:FXD FLM 29 MEGOHM 10% 1W	28480	0836-0003
A5R29	0686-1055	1	R:FXD COMP 1 MEGOHM 5% 1/2W	01121	EB 1055
A5R30	0683-1215	1	R:FXD COMP 120 OHM 5% 1/4W	01121	CB 1215
A5R31	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A5R32	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W(RECOM. REPL.)	28480	0757-0280
A5R33	0698-3444		R:FXD MET FLM 316 OHM 1% 1/8W	28480	0698-3444
A5R34	0698-7182	1	R:FXD MET FLM 30 MEGOHM 1% 2W	28480	0698-7182
A5R35	0686-2225	1	R:FXD COMP 2200 OHM 5% 1/2W	01121	EB 2225
A5R36	0686-3355	1	R:FXD COMP 3.3 MEGOHM 5% 1/2W	01121	EB 3355
A5R37	0836-0003		R:FXD FLM 29 MEGOHM 10% 1W	28480	0836-0003
A5R38	0686-4735	1	R:FXD COMP 47K OHM 5% 1/2W	01121	EB 4735
A5R39	0686-6235	1	R:FXD COMP 62K OHM 5% 1/2W	01121	EB 6235
A5R40	2100-2650	1	R:VAR FLM 200K OHM 10% LIN 1/2W	28480	2100-2650
A5R41	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A5V1	2140-0014	1	LAMP:GLOW 0.5 MILLIAMPS T-2 BULB	71744	4AB(NE-96)
A6	08412-60006	1	HIGH VOLTAGE TRANSFORMER & RECTIFIER	28480	08412-60006
A6	08412-60035	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60035
A6C1	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5S0-472M
A6C2	0160-3008		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5S0-472M
A6CR1	1901-0341	2	DIODE:SI 7000 PIV 50MA	28480	1901-0341
A6CR2	1901-0341		DIODE:SI 7000 PIV 50MA	28480	1901-0341
A6R1	0683-2235	1	R:FXD COMP 22K OHM 5% 1/4W	01121	CB 2235
A6R2	0683-1635	1	R:FXD COMP 16K OHM 5% 1/4W	01121	CB 1635
A6T1	08412-80001	1	TRANSFORMER ASSY:HIGH VOLTAGE	28480	08412-80001
A7	08412-60007	1	AMPLITUDE CHANNEL LOG CONVERTER ASSY	28480	08412-60007
A7	08412-60036	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60036
A7C1	0160-2225	2	C:FXD MICA 2000 PF 5% 300VDCW	72136	RDM19F202J3C
A7C2	0160-2225		C:FXD MICA 2000 PF 5% 300VDCW	72136	RDM19F202J3C

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A7C3	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A7C4	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A7CR1	1901-0050		DIODE:SI 200 MA AT 1V	07263	FDA 6308
A7CR2	1901-0050		DIODE:SI 200 MA AT 1V	07263	FDA 6308
A7CR3	1901-0050		DIODE:SI 200 MA AT 1V	07263	FDA 6308
A7CR4	1902-0202	2	DIODE BREAKDOWN:15.0V 5% 1W	28480	1902-0202
A7CR5	1902-0202		DIODE BREAKDOWN:15.0V 5% 1W	28480	1902-0202
A7IC1	1826-0007		IC:LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0007
A7IC2	1826-0007		IC:LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0007
A7IC3	1826-0007		IC:LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0007
A7IC4	1826-0007		IC:LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0007
A7Q1	1854-0295		TSTR:SI NPN	28480	1854-0295
A7R1	0698-3153	1	R:FXD MET FLM 3.83K OHM 1% 1/8W	28480	0698-3153
A7R2	0698-0085	2	R:FXD MET FLM 2.61K OHM 1% 1/8W	28480	0698-0085
A7R3	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A7R4	0757-0439	1	R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439
A7R5	0698-4348	1	R:FXD MET FLM 4.99 MEGOHM 1% 1/4W	28480	0698-4348
A7R6	0757-0440		R:FXD MET FLM 7.50K OHM 1% 1/8W	28480	0757-0440
A7R7	2100-1775	1	R:VAR WW 5K OHM 5% TYPE H 1W	28480	2100-1775
A7R8	0757-0440		R:FXD MET FLM 7.50K OHM 1% 1/8W	28480	0757-0440
A7R9	0757-0059	1	R:FXD MET FLM 1 MEGOHM 1% 1/2W	28480	0757-0059
A7R10	0757-0444	4	R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
A7R11	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A7R12	0811-1780	1	R:FXD WW 1K OHM 5.0% 1/4W	28480	0811-1780
A7R13	0757-0447	2	R:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447
A7R14	2100-1774	1	R:VAR WW 2K OHM 5% TYPE H 1W	28480	2100-1774
A7R15	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A7R16	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A7R17	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A7R18	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A7R19	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A8	08412-60008	1	LOW VOLTAGE POWER SUPPLY	28480	08412-60008
A8	08412-60037	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60037
A8C1	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A8C2	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A8C3	0160-2307	1	C:FXD MICA 47 PF 5%	28480	0160-2307
A8C4	0180-1748	1	C:FXD ELECT 45 UF +75-10% 250VDC	56289	39D456F250FL4-DSB
A8IC1	1820-0247	1	IC:VOLTAGE REGULATOR 40V MAX.(RECOM. REPL)	12040	LM305
A8IC2	1826-0007		IC:LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0007
A8Q1	1853-0027	1	TSTR:SI PNP	07263	S1554S
A8Q2	1854-0039	1	TSTR:SI NPN	80131	2N3053
A8Q3	1853-0052	1	TSTR:SI PNP	80131	2N3740
A8R1	0757-0290	1	R:FXD MET FLM 6.19K OHM 1% 1/8W	28480	0757-0290
A8R2	0698-0084	1	R:FXD MET FLM 2.15K OHM 1% 1/8W	28480	0698-0084
A8R3	0757-0289	1	R:FXD MET FLM 13.3K OHM 1% 1/8W	28480	0757-0289
A8R4	2100-1773		R:VAR WW 1K OHM 5% TYPE H 1W	28480	2100-1773
A8R5	0698-3491	2	R:FXD MET FLM 1K OHM 0.1% 1/8W	28480	0698-3491
A8R6	0698-3491		R:FXD MET FLM 1K OHM 0.1% 1/8W	28480	0698-3491
A8R7	0811-1670	1	R:FXD WW 2.2 OHM 5% 2W	28480	0811-1670
A8R8	2100-1777		R:VAR WW 20K OHM 5% TYPE H 1W	28480	2100-1777
A8R9	0757-0984	2	R:FXD MET FLM 10.0 OHM 1% 1/2W	28480	0757-0984
A8R10	0757-0984		R:FXD MET FLM 10.0 OHM 1% 1/2W	28480	0757-0984
A8R11	0757-0310	1	R:FXD MET FLM 133K OHM 1% 1/2W	28480	0757-0310
A9	08412-60009	1	TEST CHANNEL AMPLIFIER ASSY	28480	08412-60009
A9	08412-60038	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60038
A9C1	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C2	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C3	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A9C4	0180-0228	1	C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X9015B2-DYS
A9C5	0180-0229	1	C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A9C6	0180-0116		C:FXD ELECT 6.8 UF 10% 35VDCW	56289	150D685X9035B2-DYS
A9C7	0180-1743	2	C:FXD ELECT 0.1 UF 10% 35VDCW	56289	150D104X9035A2-DYS
A9C8	0180-1743		C:FXD ELECT 0.1 UF 10% 35VDCW	56289	150D104X9035A2-DYS
A9C9	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A9C10	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C11	0140-0205	1	C:FXD MICA 62 PF 5% 300VDCW	00853	RDM15E620J3C
A9C12	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C13	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A9C14	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C15	0160-3076	1	C:FXD CER 470 PF 5% 200VDCW	71590	OBD
A9C16	0140-0184	1	C:FXD MICA 8200 PF 1% 100VDCW	28480	0140-0184
A9C17	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C18	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A9C19	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A9C20	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9C21	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C22	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C23	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A9C24	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A9C25	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A9CR1	1902-3082	1	DIODE BREAKDOWN:4.64V 5%	28480	1902-3082
A9IC1	1820-0212	3	IC:ECL QUAD LINE RECEIVER	04713	MC1020P
A9IC2	1820-0212		IC:ECL QUAD LINE RECEIVER	04713	MC1020P
A9IC3	1820-0212		IC:ECL QUAD LINE RECEIVER	04713	MC1020P
A9L1	9140-0210		COIL/CHOKE 100 UH 5%	82142	15-1315-12J
A9L2	9100-1641	6	COIL:MOLDED CHOKE 240.0 UH	28480	9100-1641
A9L3	9100-1628	1	COIL:MOLDED CHOKE 43.0 UH 5%	28480	9100-1628
A9L4	9100-1641		COIL:MOLDED CHOKE 240.0 UH	28480	9100-1641
A9L5	9100-2209	1	INDUCTOR:37.8 UH 1%	28480	9100-2209
A9L6	9100-1641		COIL:MOLDED CHOKE 240.0 UH	28480	9100-1641
A9L7	9100-1641		COIL:MOLDED CHOKE 240.0 UH	28480	9100-1641
A9L8	9100-1641		COIL:MOLDED CHOKE 240.0 UH	28480	9100-1641
A9L9	9100-1641		COIL:MOLDED CHOKE 240.0 UH	28480	9100-1641
A9Q1	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A9Q2	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A9Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A9Q4	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A9R1	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A9R2	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A9R3	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A9R4	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A9R5	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A9R6	0757-0288	1	R:FXD MET FLM 9.09K OHM 1% 1/8W	28480	0757-0288
A9R7	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A9R8	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A9R9	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A9R10	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A9R11	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A9R12	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A9R13	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A9R14	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A9R15	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A9R16	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A9R17	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A9R18	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A9R19	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A9R20	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10	08412-60010	1	AMPLITUDE SYNCHRONOUS DETECTOR ASSY	28480	08412-60010
A10	08412-60039	1	REBUILT-EXCHANGE ASSEMBLY	28480	08412-60039
A10C1	0150-0096		C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA
A10C2	0150-0096		C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA
A10C3	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A10C4	0150-0096		C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA
A10C5	0150-0096		C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA
A10C6	0160-2202	1	C:FXD MICA 75 PF 5%	28480	0160-2202
A10C7	0160-0157	2	C:FXD MY 0.0047 UF 10% 200VDCW	56289	192P47292-PTS
A10C8	0160-0157		C:FXD MY 0.0047 UF 10% 200VDCW	56289	192P47292-PTS
A10C9	0160-0161		C:FXD MY 0.01 UF 10% 200VDCW	56289	192P10392-PTS
A10C10	0160-0161		C:FXD MY 0.01 UF 10% 200VDCW	56289	192P10392-PTS
A10C11	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A10C12	0160-0161		C:FXD MY 0.01 UF 10% 200VDCW	56289	192P10392-PTS
A10C13	0160-0161		C:FXD MY 0.01 UF 10% 200VDCW	56289	192P10392-PTS
A10C14	0180-0291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A10C15	0150-0096		C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA
A10C16	0150-0096		C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA
A10C17	0150-0096		C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA
A10CR1	1901-0050		DIODE:SI 200 MA AT 1V	07263	FDA 6308
A10CR2	1901-0050		DIODE:SI 200 MA AT 1V	07263	FDA 6308
A10IC1	1826-0007		IC:LINEAR	28480	1826-0007
A10Q1	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A10Q2	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A10Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A10Q4	1854-0414	3	TSTR:SI NPN	28480	1854-0414
A10Q5	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A10Q6	1854-0295		TSTR:SI NPN	28480	1854-0295
A10Q7	1854-0414		TSTR:SI NPN	28480	1854-0414
A10Q8	1854-0475		TSTR:SI NPN(RECOMMENDED REPLACEMENT)	28480	1854-0475
A10Q9	1854-0414		TSTR:SI NPN	28480	1854-0414
A10Q10	1854-0475		TSTR:SI NPN(RECOMMENDED REPLACEMENT)	28480	1854-0475
A10Q11	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A10Q12	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A10Q13	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A10R1	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A10R2	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A10R3	0757-0444		R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
A10R4	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A10R5	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A10R6	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A10R7	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A10R8	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A10R9	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A10R10	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A10R11	0757-0444		R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
A10R12	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A10R12			FACTORY SELECTED PART		
A10R13	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
A10R14	0698-3427	1	R:FXD MET FLM 13.3 OHM 1% 1/8W	28480	0698-3427
A10R15	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A10R16	0698-3159	1	R:FXD MET FLM 26.1K OHM 1% 1/8W	28480	0698-3159
A10R17	0757-0428		R:FXD MET FLM 1.62K OHM 1% 1/8W	28480	0757-0428
A10R18	0698-3431	2	R:FXD MET FLM 23.7 OHM 1% 1/8W	28480	0698-3431
A10R19	0698-0082		R:FXD MET FLM 464 OHM 1% 1/8W	28480	0698-0082
A10R20	0698-3431		R:FXD MET FLM 23.7 OHM 1% 1/8W	28480	0698-3431
A10R21	0757-0428		R:FXD MET FLM 1.62K OHM 1% 1/8W	28480	0757-0428
A10R22	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A10R23	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A10R24	0757-0418	2	R:FXD MET FLM 619 OHM 1% 1/8W	28480	0757-0418
A10R25	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A10R26	0757-0444		R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
A10R27	0698-7649	2	R:FXD FLM 383 OHM 0.1% 1/8W	28480	0698-7649
A10R28	0757-0418		R:FXD MET FLM 619 OHM 1% 1/8W	28480	0757-0418
A10R29	0698-5490	1	R:FXD MET FLM 2K OHM 1% 1/8W	28480	0698-5490
A10R30	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A10R30			FACTORY SELECTED PART		
A10R31	0698-3136		R:FXD MET FLM 17.8K OHM 1% 2/8W	19701	MF4C T-0
A10R32	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A10R33	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A10R34	0811-1150	1	R:FXD WW 2 X 2K OHM	28480	0811-1150
A10R34			(MATCHED PAIR) SEE R40		
A10R35	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A10R36	0698-7649		R:FXD FLM 383 OHM 0.1% 1/8W	28480	0698-7649
A10R37	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440

See introduction to this section for ordering information

Table 6-2. Replaceable Parts

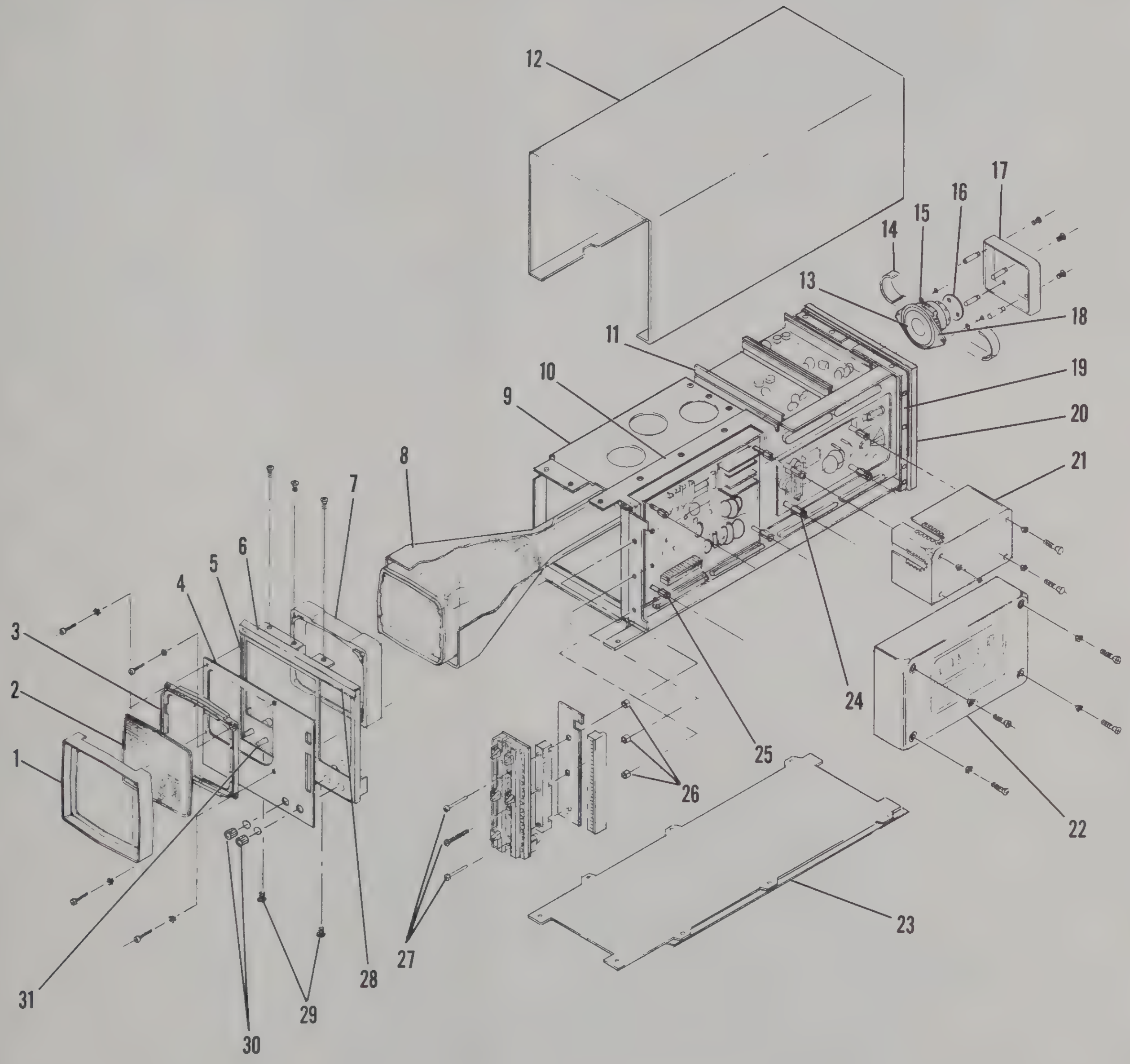
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10R38	0698-0085		R:FXD MET FLM 2.61K OHM 1% 1/8W	28480	0698-0085
A10R39	0757-0447		R:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447
A10R40			PART OF R34		
A10R41	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A10R42	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A10R43	0698-3162	1	R:FXD MET FLM 46.4K OHM 1% 1/8W	28480	0698-3162
A10R44	0698-3155		R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A10R45	0698-3155		R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A10R46	0698-3155		R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A10R47	0698-3440		R:FXD MET FLM 196 OHM 1% 1/8W	28480	0698-3440
			CHASSIS PARTS		
C1	0180-2198	1	C:FXD ELECT 2700 UF +75-10% 25VDCW	56289	36D272G025AA2C-DQB
CR1	1901-0049	2	DIODE:SILICON 50PIV	28480	1901-0049
CR2	1901-0049		DIODE:SILICON 50PIV	28480	1901-0049
CR3	1901-0029	2	DIODE:SILICON 600 PIV	28480	1901-0029
CR4	1901-0029		DIODE:SILICON 600 PIV	28480	1901-0029
F1	2110-0064	2	FUSE:0.125A 125V SLO-BLO	28480	2110-0064
F1	1400-0084	1	FUSEHOLDER:EXTRACTOR POST TYPE	75915	342014
F1	0900-0016	1	"O" RING:11/16"	28480	0900-0016
F2	2110-0064		FUSE:0.125A 125V SLO-BLO	28480	2110-0064
F2	08412-40002	1	FUSEHOLDER	28480	08412-40002
J1	1251-0055	1	CONNECTOR:MALE 24 CONTACTS	28480	1251-0055
J2	1250-0118	5	CONNECTOR:BNC	24931	28JR 128-1
J3	1250-0118		CONNECTOR:BNC	24931	28JR 128-1
J4	1250-0118		CONNECTOR:BNC	24931	28JR 128-1
J5	1250-0118		CONNECTOR:BNC	24931	28JR 128-1
J6	1250-0118		CONNECTOR:BNC	24931	28JR 128-1
L1	01200-66001	1	COIL ASSY:ALIGNMENT	28480	01200-66001
R1	2100-2843	1	R:VAR COMP 5K OHM 10% LIN 1/2W	28480	2100-2843
R2	2100-2847	1	R:VAR COMP 5 MEGOHM 20% LIN 1/2W	28480	2100-2847
R2	5040-0453	1	COVER:POTENTIOMETER(FOCUS)	28480	5040-0453
R3	2100-2838	2	R:VAR COMP 20K OHM 10% LIN 0.5W	28480	2100-2838
R4	2100-2869	1	R:VAR WW 10 OHM 10% LIN 3/4W	28480	2100-2869
R5	2100-2838		R:VAR COMP 20K OHM 10% LIN 0.5W	28480	2100-2838
R6	0683-1045	1	R:FXD COMP 100K OHMS 5% 1/4W	01121	CB 1045
R7	0683-1035	1	R:FXD COMP 10K OHM 5% 1/4W	01121	CB 1035
R8	2100-2492	1	R:VAR COMP 5K OHM 20% LIN 1/2W	28480	2100-2492
R9	2100-2083	1	R:VAR COMP 20K OHM 20% LIN 1/2W	28480	2100-2083
S1	3101-1338	1	SWITCH:SLIDE DPDT 0.5A 125V AC/DC	79727	GF126-0017
T1	9100-2850	1	TRANSFORMER:175V 50-400HZ	28480	9100-2850
V1	5083-9081	1	CRT	28480	5083-9081
XA1	1251-1190	2	CONNECTOR:PC EDGE (2 X 12) 24 CONTACT	71785	251-12-30-261
XA2	1251-2309	4	CONNECTOR:PC 12 CONTACTS	71785	250-12-30-210
XA3	1251-0159	1	CONNECTOR:PC EDGE 2 X 15 CONTACT	71785	251-15-30-261
XA4	1251-2308	1	CONNECTOR:PC 22 CONTACTS	00779	582379-9
XA4	1251-2075	13	CONTACT:PC CONNECTOR RT ANGLE	00779	66149-3
XA5	5060-0115	1	CONNECTOR ASSY:15 CONTACT	28480	5060-0115
XA6			NOT ASSIGNED		
XA7	1251-2309		CONNECTOR:PC 12 CONTACTS	71785	250-12-30-210
XA8	1251-1190		CONNECTOR:PC EDGE (2 X 12) 24 CONTACT	71785	251-12-30-261
XA9	1251-2309		CONNECTOR:PC 12 CONTACTS	71785	250-12-30-210
XA10	1251-2309		CONNECTOR:PC 12 CONTACTS	71785	250-12-30-210
XV1	1200-0037	1	SOCKET:CRT TUBE	72825	97097
XV1	1200-0050	1	CONTACT:CRT SOCKET	72825	9553-1
	08412-60004	1	BOARD ASSY:EXTENDER	28480	08412-60004

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			CABINET PARTS		
			NOTE		
			STANDARD. INDICATES 8412A, INCLUDES MINT GRAY AND OLIVE BLACK FRONT PANEL AND OLIVE GRAY CABINFT.		
			OPTION A85. INDICATES LITE GRAY AND BLACK FRONT PANEL.		
			OPTION X95. INDICATES COMPLETE 8412A COLOR SCHEME. INCLUDES LITE GRAY AND BLACK FRONT PANEL & BLUE GRAY CABINET.		
1	5040-0508	1	SHIELD:LIGHT,OLIVE BLACK(STANDARD)	28480	5040-0508
1	5040-0444	1	SHIELD:LIGHT,BLACK NYLON(OPT A85,X95)	28480	5040-0444
2	10179A	1	CONTRAST IMPROVEMENT SCREEN	28480	10179A
3	5020-0476	1	BEZEL:CRT	28480	5020-0476
4	08412-00025	1	PANEL:FRONT,MINT GRAY & OLIVE BLK(STD)	28480	08412-00025
4	08412-00001	1	PANEL:FRONT,LITE GRAY & BLK(OPT A85,X95	28480	08412-00001
5	08412-20013	1	SUB-PANEL:FRONT	28480	08412-20013
6	5020-3281	1	TRIM,NAMEPLATE	28480	5020-3281
7	01200-44703	1	SUPPORT:CRT SHIELD	28480	01200-44703
8	01200-60601	1	SHIELD:CRT	28480	01200-60601
9	08412-00003	1	SUPPORT:TOP CROSS	28480	08412-00003
10	08412-00007	1	FRAME:RIGHT SIDE	28480	08412-00007
11	08412-20016	6	SHIELD:PC BOARD	28480	08412-20016
12	08412-00027	1	COVER ASSY:TOP, OLIVE GRAY(STD)	28480	08412-00027
12	08412-00017	1	COVER ASSY:TOP, BLUE GRAY(OPT X95)	28480	08412-00017
13	0905-0330	1	SEAL "O" RING 2.164 ID	03818	2-38N525-6
14	00180-41207	35	BRACKET:PLASTIC	28480	00180-41207
15	1400-0026	1	CLAMP:HOSE	66295	36H
16	1200-0408	1	COVER PLATE:CRT SOCKET(RECOMMENDED REPL.)	28480	1200-0408
17	08412-00012	1	COVER:CRT REAR	28480	08412-00012
18	08412-40003	1	RETAINER:R-SHIELD	28480	08412-40003
19	08412-20019	1	SUB-PANEL:REAR	28480	08412-20019
20	08412-00002	1	PANEL:REAR	28480	08412-00002
21	08412-00010	1	COVER:HVPS RECTIFIER	28480	08412-00010
22	08412-00011	1	COVER:HVPS REGULATOR	28480	08412-00011
23	08412-00028	1	COVER ASSY:BOTTOM,OLIVE GRAY(STD)	28480	08412-00028
23	08412-00018	1	COVER ASSY:BOTTOM,BLUE GRAY(OPT X95)	28480	08412-00018
24	08412-20018	4	SCREW:ADAPTER (LONG)	28480	08412-20018
24	08412-20023	1	INSULATOR:HVPS	28480	08412-20023
25	08412-20017	4	SCREW:ADAPTER (SHORT)	28480	08412-20017
26	08412-20021	3	SPACER:INSULATOR SWITCH	28480	08412-20021
27	0520-0226	1	SCREW:FIL HD POZI DR 2-56 X 1.250" LG	00000	OBD
28	7120-2330	1	PLATE:IDENTIFICATION	28480	7120-2330
29	08412-20020	2	PIN EXTRACTOR	28480	08412-20020
30	0370-0151	2	KNOB:ROUND FOR 0.125" DIA SHAFT	28480	0370-0151
31	08412-40001	2	KNOB CONTROL	28480	08412-40001

See introduction to this section for ordering information

Table 6-2. Reference Designation Index (Cont'd)



Cabinet Parts, Exploded View

Table 6-3. Code List of Manufacturers

MFR NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
00000	U.S.A. COMMON	ANY SUPPLIER OF U.S.A.	
00779	AMP INC.(AIRCRAFT MARINE PROD.)	HARRISBURG, PA.	17101
00853	SANGAMO ELECTRIC CO.PICKENS DIV.	PICKENS, S.C.	29671
01121	ALLEN BRADLEY CO.	MILWAUKEE, WIS.	53204
04713	MOTOROLA SEMICONDUCTOR PROD.INC.	PHOENIX, ARIZ.	85008
07263	FAIRCHILD CAMERA & INST. CORP. SEMICONDUCTOR DIV.	MOUNTAIN VIEW, CALIF.	94040
12040	NATIONAL SEMICONDUCTOR CORP.	DANBURY, CONN.	06810
19701	ELECTRA/MIDLAND CORP.	MINERAL WELLS, TEX.	76067
24931	SPECIALTY CONNECTOR CO. INC.	INDIANAPOLIS, IND.	46227
28480	HEWLETT-PACKARD COMPANY	PALO ALTO, CALIF.	94304
56289	SPRAGUE ELECTRIC CO.	N. ADAMS, MASS.	01247
66295	WITTEK MFG. CO.	CHICAGO, ILL.	60623
71590	GLOBE UNION INC. CENTRALAB DIV.	MILWAUKEE, WISC.	53201
71744	CHICAGO MINIATURE LAMP WORKS	CHICAGO, ILL.	60640
71785	CINCH MFG. CO. DIV TRW INC.	ELK GROVE VILLAGE, ILL.	
72136	ELECTRO MOTIVE MFG. CO. INC.	WILLIMANTIC, CONN.	06226
72825	EBY HUGH H. INC.	PHILADELPHIA, PA.	19144
72982	ERIE TECHNOLOGICAL PROD. INC.	ERIE, PA.	16512
75915	LITTELFUSE INC.	DES PLAINES, ILL.	60016
79727	CONTINENTAL-WIRT ELECTRONICS CORP.	PHILADELPHIA, PA.	19144
80131	ELECTRONIC INDUSTRIES ASSOCIATION	WASHINGTON D.C.	20006
82142	AIRCO SPEER ELECT. COMP.	DU BOIS, PA.	15801
84411	TRW CAPACITOR DIV.	OGALLALA, NEBR.	69153
91418	RADIO MATERIALS CO.	CHICAGO, ILL.	60646
91506	AUGAT INC.	ATTLEBORO, MASS.	02703
93332	SYLVANIA ELECTRIC PROD. INC. SEMICONDUCTOR DIV.	WOBURN, MASS.	01801

SECTION VII
SCHEMATIC DIAGRAMS

7-1. INTRODUCTION.

7-2. The schematic diagrams in this section represent the circuits electrically. They are not wiring diagrams, though wire colors are given where practical.

7-3. The large numbers in the lower right corners of the schematics are the schematic numbers. These numbers are used to cross reference connections between schematics. Smaller numbers preceeded by A located below the schematic number list the assemblies included in the schematic.

7-4. Some of the general information obtainable from the schematic diagrams is shown in Figure 7-1. Notes and explanations of symbols pertaining to all the diagrams are contained in Figure 7-2. Figure 7-2 also contains the test setup and measurement conditions required to obtain the normal test point waveforms and voltages noted on the schematic diagrams. Notes about specific components, circuits, or conditions are given on the diagram to which they apply.

7-5. As an aid to finding components and assemblies in the set of diagrams, each diagram has a box labelled Reference Designations that contains all the reference designations appearing on the diagram.

7-6. An asterisk indicates a factory selected part; the component value shown is the typical or most commonly selected value.

7-7. Component procurement information and specific component descriptions are included in Section VI. Refer to page 6-1 for information on how to order parts.

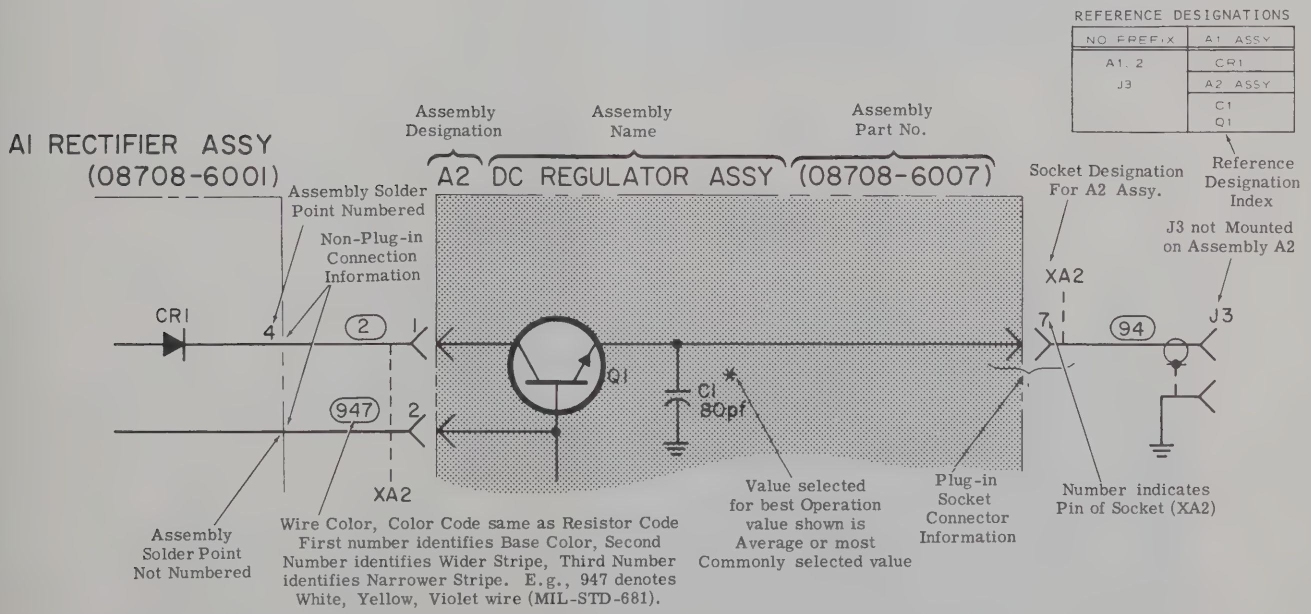

REFERENCE DESIGNATIONS
NO PREFIX
A1 ASSY
A1, 2
J3
CR1
A2 ASSY
C1
Q1
AI RECTIFIER ASSY
(08708-6001)
Assembly Designation
Assembly Name
Assembly Part No.
A2 DC REGULATOR ASSY (08708-6007)
Assembly Solder Point Numbered
Non-Plug-in Connection Information
Socket Designation For A2 Assy.
Reference Designation Index
J3 not Mounted on Assembly A2
CR1
4
2
1
947
2
XA2
Q1
C1
80pf
*
XA2
7
94
J3
Assembly Solder Point Not Numbered
Wire Color, Color Code same as Resistor Code First number identifies Base Color, Second Number identifies Wider Stripe, Third Number identifies Narrower Stripe. E.g., 947 denotes White, Yellow, Violet wire (MIL-STD-681).
Value selected for best Operation value shown is Average or most Commonly selected value
Plug-in Socket Connector Information
Number indicates Pin of Socket (XA2)

Figure 7-1. General Information on Schematic Diagrams

1. Resistance is in ohms and capacitance is in microfarads unless otherwise noted.

2. P/O = part of.

3. *Asterisk denotes a factory-selected value. Value shown is typical.
Capacitors may be omitted or resistors jumpered.

4. ⊘ Screwdriver adjustment.

○ Panel control.

5. ▭ Encloses front panel designations.

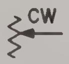
⬚ Encloses rear panel designation.

6. ——— – – ——— Circuit assembly borderline.

– – – – – – – Other assembly borderline.

7. ——►—— Heavy line with arrows indicates path and direction of main signal.

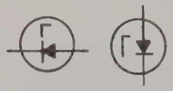
– ◄— —– · Heavy dashed line with arrows indicates path and direction of main feedback.

8. 

Wiper moves toward CW with clockwise rotation of control as viewed from shaft or knob.

9. ❶ Numbers in circles on circuit assemblies show locations of test points.

10. ▢ Encloses wire color code. Code used (MIL-STD-681) is the same as the resistor color code. First number indentifies the base color, second number the wider stripe, and the third number identifies the narrower stripe. E.g., (947) denotes white base, yellow wide stripe, violet narrow stripe.

11. 
Voltage regulator (breakdown diode).

12. CONDITIONS FOR WAVEFORMS AND DC VOLTAGES ON SCHEMATICS.

a. For Model 8407A Network Analyzer Mainframe,

1) Connect equipment as shown in test setup.

2) Set 8407A controls as follows:

DISPLAY REFERENCE CAL - Zero dB at top switch positions.

DISPLAY REFERENCE - 10 dB/step switch at one position down from top (+10 dB), and 1 dB/step switch at top position (0 dB).

REF CHANNEL LEVEL ADJ - Middle position.

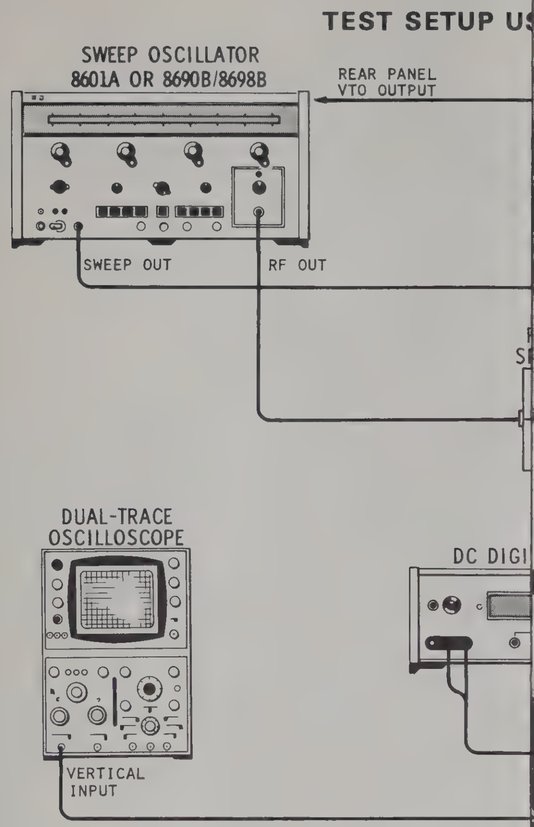
AMPL VERNIER - Midrange.

PHASE VERNIER - Midrange.

3) Set sweep oscillator controls for symmetrical sweep, 10 kHz or narrower sweep width, fast sweep mode, and output signal unmodulated.

4) Adjust sweep oscillator RF output for an 8407A REF CHANNEL LEVEL meter indication in the middle of the OPERATE range.

Figure 7-2. Schematic Diagram Notes (Sheet 1 of 3)



b. For Model 8410A Network Analyzer

1) Connect equipment as shown in tes
2) Set 8410A controls as follows:

FREQ. RANGE - Frequency to

AMPLITUDE TEST CHANNEL G

AMPL VERNIER - Midrange.

PHASE VERNIER - Midrange.

SWEEP STABILITY - Adjust for b

3) Set sweep oscillator controls
output signal unmodulated.

4) Adjust sweep oscillator RF outpu
in the middle of the OPERATE

c. On Model 8412A Plug-in, set control

MODE to DUAL.

AMPL DB/DIV to 10.

PHASE DEG/DIV to 90.

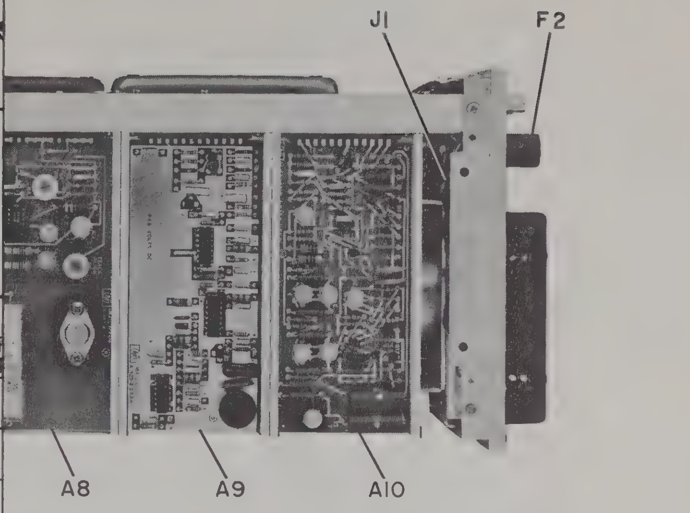
PHASE OFFSET polarity to + .

DEGREES to zero.

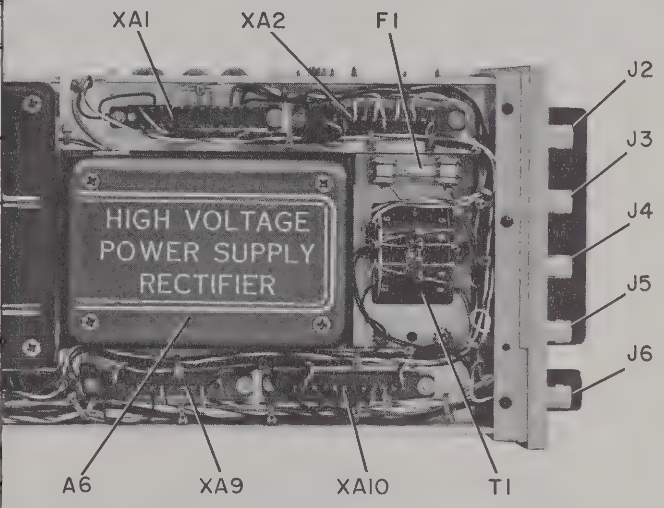
INTENSITY for moderate trace i

Figure 7-2. Schem

TOM VIEW



T SIDE VIEW



T SIDE VIEW

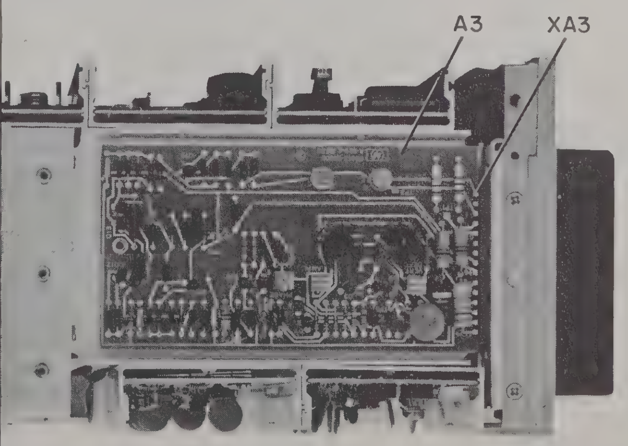


Figure 7-3. Location of Major Assemblies (Sheet 2 of 2)

1. Resistance is in ohms and capacitance is in microfarads unless otherwise noted.

2. P/O = part of.

3. *Asterisk denotes a factory-selected value. Value shown is typical. Capacitors may be omitted or resistors jumpered.

4. ⊘ Screwdriver adjustment.

○ Panel control.

5. ▭ Encloses front panel designations.

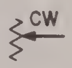
⬚ Encloses rear panel designation.

6. ——— — — ——— Circuit assembly borderline.

- - - - - - - Other assembly borderline.

7. ——▶—— Heavy line with arrows indicates path and direction of main signal.

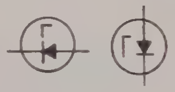
- ◀— — · Heavy dashed line with arrows indicates path and direction of main feedback.

8. 

Wiper moves toward CW with clockwise rotation of control as viewed from shaft or knob.

9. ❶ Numbers in circles on circuit assemblies show locations of test points.

10. ⬭ Encloses wire color code. Code used (MIL-STD-681) is the same as the resistor color code. First number indentifies the base color, second number the wider stripe, and the third number identifies the narrower stripe. E.g., (947) denotes white base, yellow wide stripe, violet narrow stripe.

11. 
Voltage regulator (breakdown diode).

12. CONDITIONS FOR WAVEFORMS AND DC VOLTAGES ON SCHEMATICS.

a. For Model 8407A Network Analyzer Mainframe,

1) Connect equipment as shown in test setup.

2) Set 8407A controls as follows:

DISPLAY REFERENCE CAL - Zero dB at top switch positions.

DISPLAY REFERENCE - 10 dB/step switch at one position down from top (+10 dB), and 1 dB/step switch at top position (0 dB).

REF CHANNEL LEVEL ADJ - Middle position.

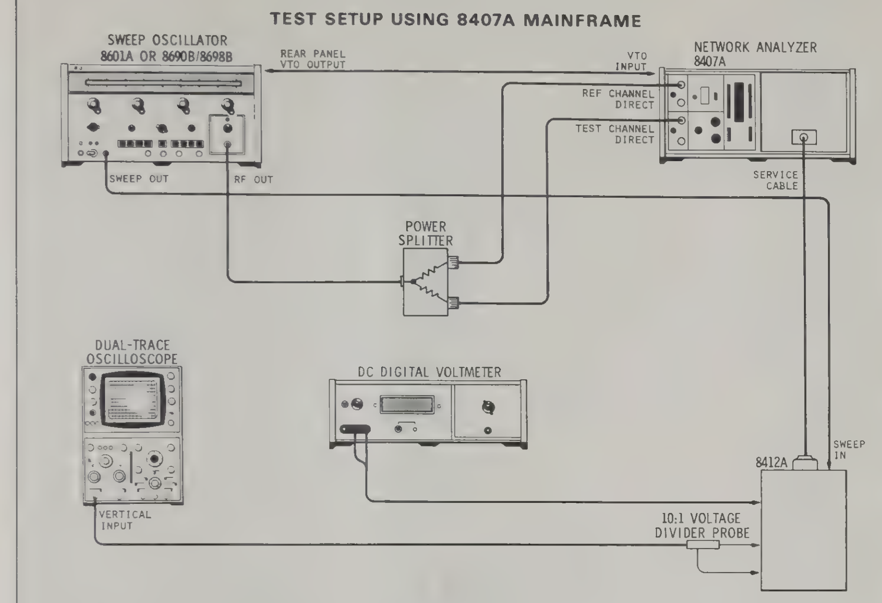
AMPL VERNIER - Midrange.

PHASE VERNIER - Midrange.

3) Set sweep oscillator controls for symmetrical sweep, 10 kHz or narrower sweep width, fast sweep mode, and output signal unmodulated.

4) Adjust sweep oscillator RF output for an 8407A REF CHANNEL LEVEL meter indication in the middle of the OPERATE range.

Figure 7-2. Schematic Diagram Notes (Sheet 1 of 3)



b. For Model 8410A Network Analyzer Mainframe,

1) Connect equipment as shown in test setup.
2) Set 8410A controls as follows:
   - FREQ. RANGE - Frequency to match sweep oscillator.
   - AMPLITUDE TEST CHANNEL GAIN - 55 dB.
   - AMPL VERNIER - Midrange.
   - PHASE VERNIER - Midrange.
   - SWEEP STABILITY - Adjust for best phase lock.
3) Set sweep oscillator controls for symmetrical sweep over narrowest band possible and output signal unmodulated.
4) Adjust sweep oscillator RF output for an 8410A REF CHANNEL LEVEL meter indication in the middle of the OPERATE range.

c. On Model 8412A Plug-in, set controls as follows:

- MODE to DUAL.
- AMPL DB/DIV to 10.
- PHASE DEG/DIV to 90.
- PHASE OFFSET polarity to + .
- DEGREES to zero.
- INTENSITY for moderate trace intensity.

Figure 7-2. Schematic Diagram Notes (Sheet 2 of 3)

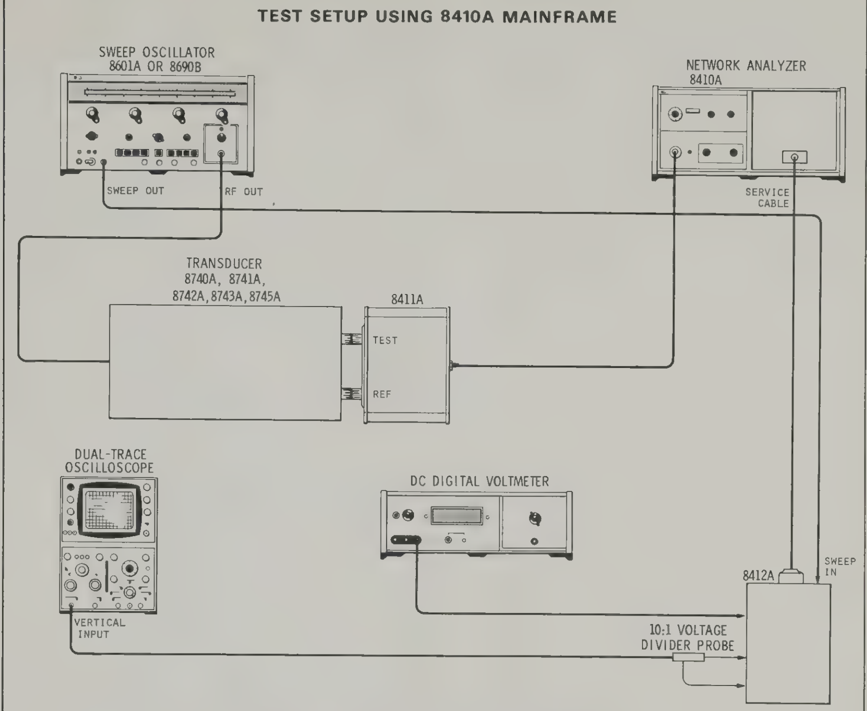


Figure 7-2. Schematic Diagram Notes (Sheet 3 of 3)

TOP VIEW

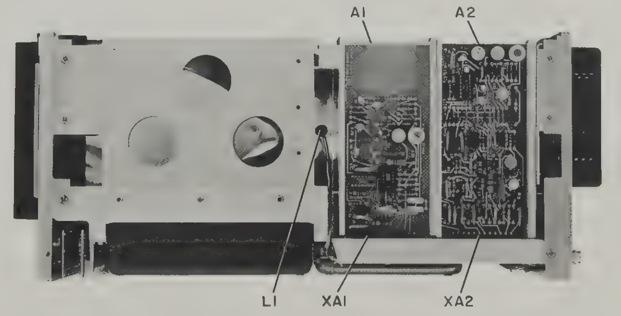
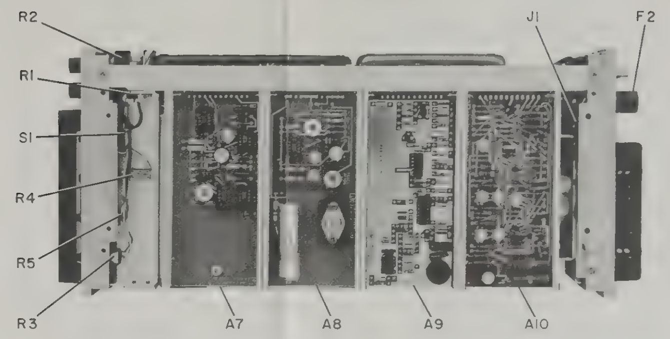
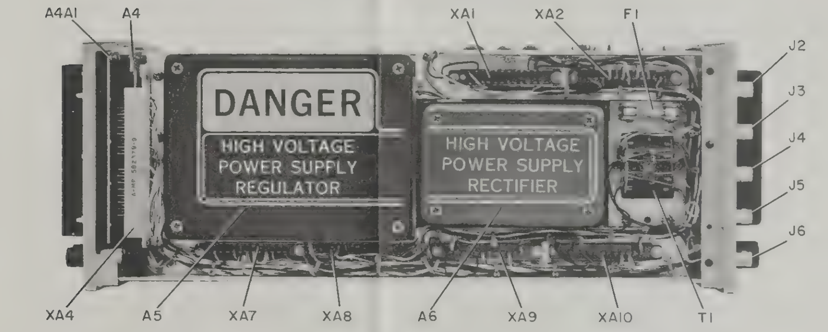


Figure 7-3. Location of Major Assemblies (Sheet 1 of 2)

BOTTOM VIEW



RIGHT SIDE VIEW



LEFT SIDE VIEW

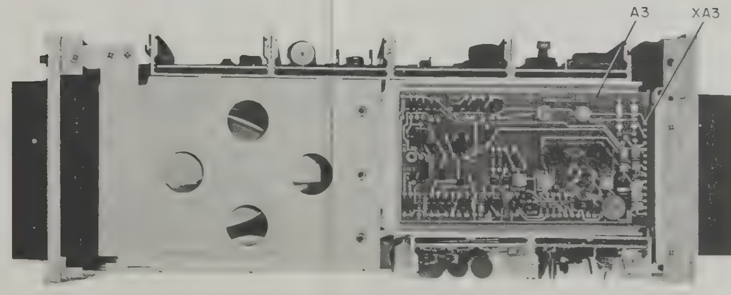
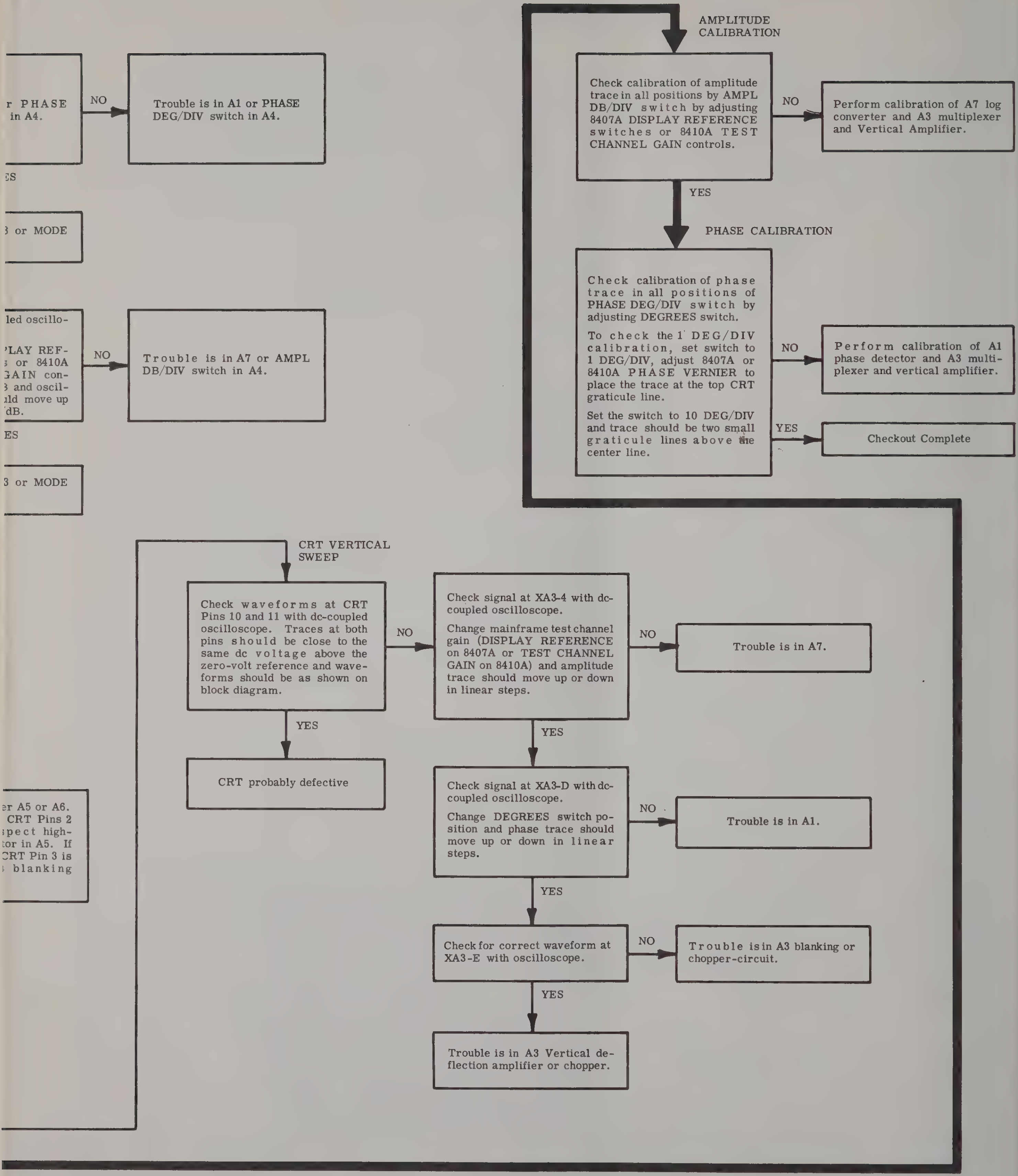


Figure 7-3. Location of Major Assemblies (Sheet 2 of 2)


r PHASE
in A4.
NO
Trouble is in A1 or PHASE DEG/DIV switch in A4.
ES
3 or MODE
led oscillo-
PLAY REF-
s or 8410A
GAIN con-
3 and oscil-
uld move up
dB.
NO
Trouble is in A7 or AMPL DB/DIV switch in A4.
ES
3 or MODE
er A5 or A6.
CRT Pins 2
spect high-
tor in A5. If
CRT Pin 3 is
blanking
AMPLITUDE CALIBRATION
Check calibration of amplitude trace in all positions by AMPL DB/DIV switch by adjusting 8407A DISPLAY REFERENCE switches or 8410A TEST CHANNEL GAIN controls.
NO
Perform calibration of A7 log converter and A3 multiplexer and Vertical Amplifier.
YES
PHASE CALIBRATION
Check calibration of phase trace in all positions of PHASE DEG/DIV switch by adjusting DEGREES switch.
To check the 1° DEG/DIV calibration, set switch to 1 DEG/DIV, adjust 8407A or 8410A PHASE VERNIER to place the trace at the top CRT graticule line.
Set the switch to 10 DEG/DIV and trace should be two small graticule lines above the center line.
NO
Perform calibration of A1 phase detector and A3 multiplexer and vertical amplifier.
YES
Checkout Complete
CRT VERTICAL SWEEP
Check waveforms at CRT Pins 10 and 11 with dc-coupled oscilloscope. Traces at both pins should be close to the same dc voltage above the zero-volt reference and waveforms should be as shown on block diagram.
YES
CRT probably defective
NO
Check signal at XA3-4 with dc-coupled oscilloscope.
Change mainframe test channel gain (DISPLAY REFERENCE on 8407A or TEST CHANNEL GAIN on 8410A) and amplitude trace should move up or down in linear steps.
NO
Trouble is in A7.
YES
Check signal at XA3-D with dc-coupled oscilloscope.
Change DEGREES switch position and phase trace should move up or down in linear steps.
NO
Trouble is in A1.
YES
Check for correct waveform at XA3-E with oscilloscope.
NO
Trouble is in A3 blanking or chopper-circuit.
YES
Trouble is in A3 Vertical deflection amplifier or chopper.

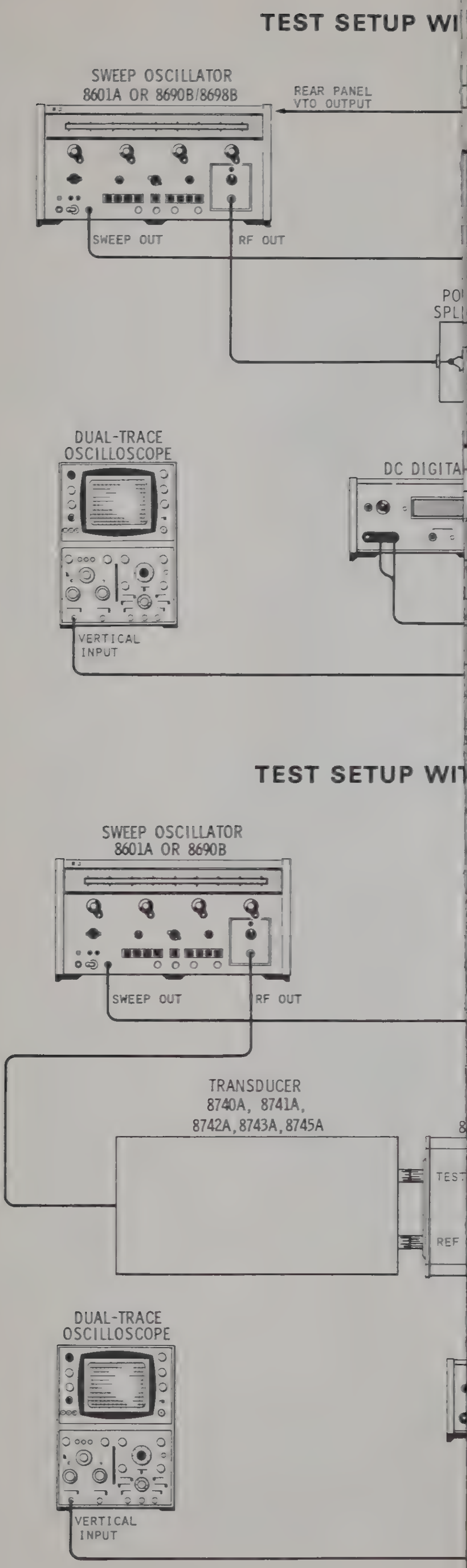


Figure 7-5. Test Setup for Tro

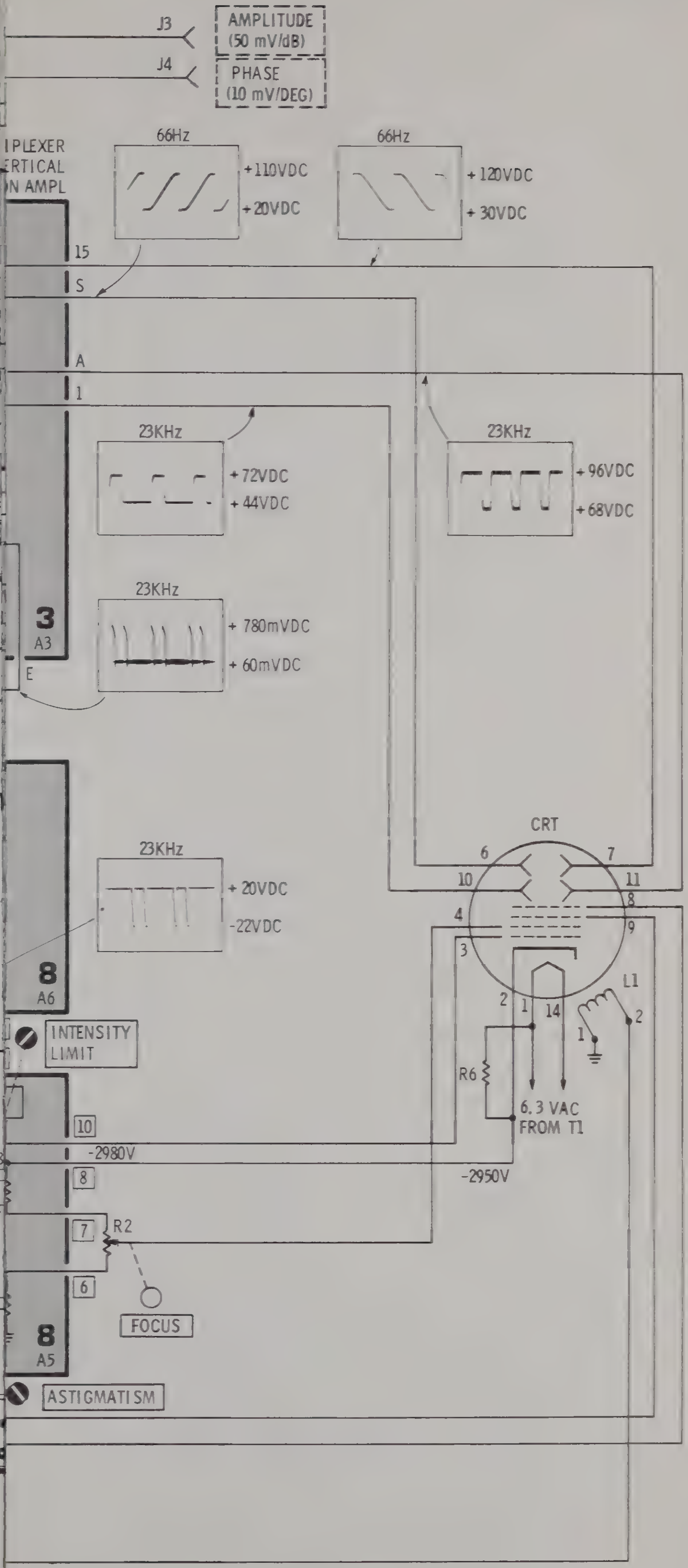
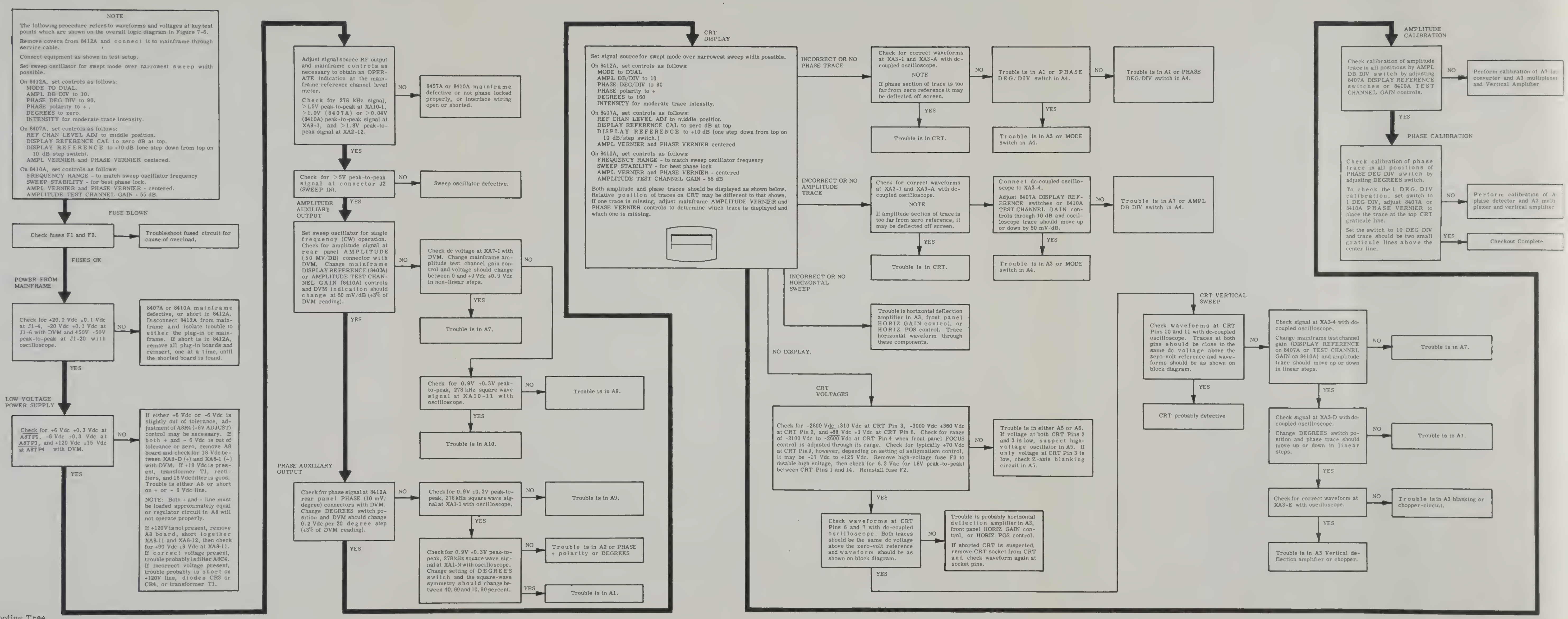


Figure 7-6. Detailed Block Diagram



NOTE

The following procedure refers to waveforms and voltages at key test points which are shown on the overall logic diagram in Figure 7-6.

Remove covers from 8412A and connect it to mainframe through service cable.

Connect equipment as shown in test setup.

Set sweep oscillator for swept mode over narrowest sweep width possible.

On 8412A, set controls as follows:
MODE TO DUAL.
AMPL DB DIV to 10.
PHASE DEG DIV to 90.
PHASE polarity to + .
DEGREES to zero.
INTENSITY for moderate trace intensity.

On 8407A, set controls as follows:
REF CHAN LEVEL ADJ to middle position.
DISPLAY REFERENCE CAL to zero dB at top.
DISPLAY REFERENCE to +10 dB (one step down from top on 10 dB step switch).
AMPL VERNIER and PHASE VERNIER centered.

On 8410A, set controls as follows:
FREQUENCY RANGE - to match sweep oscillator frequency
SWEEP STABILITY - for best phase lock.
AMPL VERNIER and PHASE VERNIER - centered.
AMPLITUDE TEST CHANNEL GAIN - 55 dB.

Check fuses F1 and F2.

Troubleshoot fused circuit for cause of overload.

Check for +20.0 Vdc ±0.1 Vdc at J1-4, -20 Vdc ±0.1 Vdc at J1-6 with DVM and 450V ±50V peak-to-peak at J1-20 with oscilloscope.

8407A or 8410A mainframe defective, or short in 8412A. Disconnect 8412A from mainframe and isolate trouble to either the plug-in or mainframe. If short is in 8412A, remove all plug-in boards and reinsert, one at a time, until the shorted board is found.

Check for +6 Vdc ±0.3 Vdc at A8TP1, -6 Vdc ±0.3 Vdc at A8TP3, and +120 Vdc ±15 Vdc at A8TP4 with DVM.

If either +6 Vdc or -6 Vdc is slightly out of tolerance, adjustment of A8R4 (+6V ADJUST) control may be necessary. If both + and - 6 Vdc is out of tolerance or zero, remove A8 board and check for 18 Vdc between XA8-D (+) and XA8-1 (-) with DVM. If +18 Vdc is present, transformer T1, rectifiers, and 18 Vdc filter is good. Trouble is either A8 or short on + or - 6 Vdc line.

NOTE: Both + and - line must be loaded approximately equal or regulator circuit in A8 will not operate properly.

If +120V is not present, remove A8 board, short together XA8-11 and XA8-12, then check for +90 Vdc ±9 Vdc at XA8-11. If correct voltage present, trouble probably is filter A8C4. If incorrect voltage present, trouble probably is short on +120V line, diodes CR3 or CR4, or transformer T1.

Adjust signal source RF output and mainframe controls as necessary to obtain an OPERATE indication at the mainframe reference channel level meter.

Check for 278 kHz signal, >1.5V peak-to-peak at XA10-1, >1.0V (8407A) or >0.04V (8410A) peak-to-peak signal at XA9-1, and >1.8V peak-to-peak signal at XA2-12.

8407A or 8410A mainframe defective or not phase locked properly, or interface wiring open or shorted.

Check for >5V peak-to-peak signal at connector J2 (SWEEP IN).

Sweep oscillator defective.

Set sweep oscillator for single frequency (CW) operation. Check for amplitude signal at rear panel AMPLITUDE (50 MV/DB) connector with DVM. Change mainframe DISPLAY REFERENCE (8407A) or AMPLITUDE TEST CHANNEL GAIN (8410A) controls and DVM indication should change at 50 mV/dB (±3% of DVM reading).

Check dc voltage at XA7-1 with DVM. Change mainframe amplitude test channel gain control and voltage should change between 0 and +9 Vdc ±0.9 Vdc in non-linear steps.

Trouble is in A7.

Check for 0.9V ±0.3V peak-to-peak, 278 kHz square wave signal at XA10-11 with oscilloscope.

Trouble is in A9.

Trouble is in A10.

Check for phase signal at 8412A rear panel PHASE (10 mV/degree) connectors with DVM. Change DEGREES switch position and DVM should change 0.2 Vdc per 20 degree step (±3% of DVM reading).

Check for 0.9V ±0.3V peak-to-peak, 278 kHz square wave signal at XA1-1 with oscilloscope.

Trouble is in A9.

Check for 0.9V ±0.3V peak-to-peak, 278 kHz square wave signal at XA1-N with oscilloscope. Change setting of DEGREES switch and the square-wave symmetry should change between 40/60 and 10/90 percent.

Trouble is in A2 or PHASE ± polarity or DEGREES

Trouble is in A1.

Set signal source for swept mode over narrowest sweep width possible.

On 8412A, set controls as follows:
MODE to DUAL
AMPL DB/DIV to 10
PHASE DEG/DIV to 90
PHASE polarity to +
DEGREES to 160
INTENSITY for moderate trace intensity.

On 8407A, set controls as follows:
REF CHAN LEVEL ADJ to middle position
DISPLAY REFERENCE CAL to zero dB at top
DISPLAY REFERENCE to +10 dB (one step down from top on 10 dB/step switch.)
AMPL VERNIER and PHASE VERNIER centered

On 8410A, set controls as follows:
FREQUENCY RANGE - to match sweep oscillator frequency
SWEEP STABILITY - for best phase lock
AMPL VERNIER and PHASE VERNIER - centered
AMPLITUDE TEST CHANNEL GAIN - 55 dB

Both amplitude and phase traces should be displayed as shown below. Relative position of traces on CRT may be different to that shown. If one trace is missing, adjust mainframe AMPLITUDE VERNIER and PHASE VERNIER controls to determine which trace is displayed and which one is missing.

Check for correct waveforms at XA3-1 and XA3-A with dc-coupled oscilloscope.

NOTE

If phase section of trace is too far from zero reference it may be deflected off screen.

Trouble is in CRT.

Trouble is in A1 or PHASE DEG/DIV switch in A4.

Trouble is in A3 or MODE switch in A4.

Trouble is in A1 or PHASE DEG/DIV switch in A4.

Check for correct waveforms at XA3-1 and XA3-A with dc-coupled oscilloscope.

NOTE

If amplitude section of trace is too far from zero reference, it may be deflected off screen.

Trouble is in CRT.

Connect dc-coupled oscilloscope to XA3-4.

Adjust 8407A DISPLAY REFERENCE switches or 8410A TEST CHANNEL GAIN controls through 10 dB and oscilloscope trace should move up or down by 50 mV/dB.

Trouble is in A3 or MODE switch in A4.

Trouble is in A7 or AMPL DB DIV switch in A4.

Trouble is horizontal deflection amplifier in A3, front panel HORIZ GAIN control, or HORIZ POS control. Trace horizontal waveform through these components.

Check for -2800 Vdc ±310 Vdc at CRT Pin 3, -3000 Vdc ±360 Vdc at CRT Pin 2, and +68 Vdc ±3 Vdc at CRT Pin 8. Check for range of -2100 Vdc to -2600 Vdc at CRT Pin 4 when front panel FOCUS control is adjusted through its range. Check for typically +70 Vdc at CRT Pin 9, however, depending on setting of astigmatism control, it may be -17 Vdc to +125 Vdc. Remove high-voltage fuse F2 to disable high voltage, then check for 6.3 Vac (or 18V peak-to-peak) between CRT Pins 1 and 14. Reinstall fuse F2.

Trouble is in either A5 or A6. If voltage at both CRT Pins 2 and 3 is low, suspect high-voltage oscillator in A5. If only voltage at CRT Pin 3 is low, check Z-axis blanking circuit in A5.

Check waveforms at CRT Pins 6 and 7 with dc-coupled oscilloscope. Both traces should be the same dc voltage above the zero-volt reference and waveform should be as shown on block diagram.

Trouble is probably horizontal deflection amplifier in A3, front panel HORIZ GAIN control, or HORIZ POS control.

If shorted CRT is suspected, remove CRT socket from CRT and check waveform again at socket pins.

Check waveforms at CRT Pins 10 and 11 with dc-coupled oscilloscope. Traces at both pins should be close to the same dc voltage above the zero-volt reference and waveforms should be as shown on block diagram.

CRT probably defective

Check signal at XA3-4 with dc-coupled oscilloscope.

Change mainframe test channel gain (DISPLAY REFERENCE on 8407A or TEST CHANNEL GAIN on 8410A) and amplitude trace should move up or down in linear steps.

Trouble is in A7.

Check signal at XA3-D with dc-coupled oscilloscope.

Change DEGREES switch position and phase trace should move up or down in linear steps.

Trouble is in A1.

Check for correct waveform at XA3-E with oscilloscope.

Trouble is in A3 blanking or chopper-circuit.

Trouble is in A3 Vertical deflection amplifier or chopper.

Check calibration of amplitude trace in all positions by AMPL DB DIV switch by adjusting 8407A DISPLAY REFERENCE switches or 8410A TEST CHANNEL GAIN controls.

Perform calibration of A7 lo converter and A3 multiplexer and Vertical Amplifier

Check calibration of phase trace in all positions of PHASE DEG DIV switch by adjusting DEGREES switch.

To check the 1 DEG/DIV calibration, set switch to 1 DEG/DIV, adjust 8407A or 8410A PHASE VERNIER to place the trace at the top CRT graticule line.

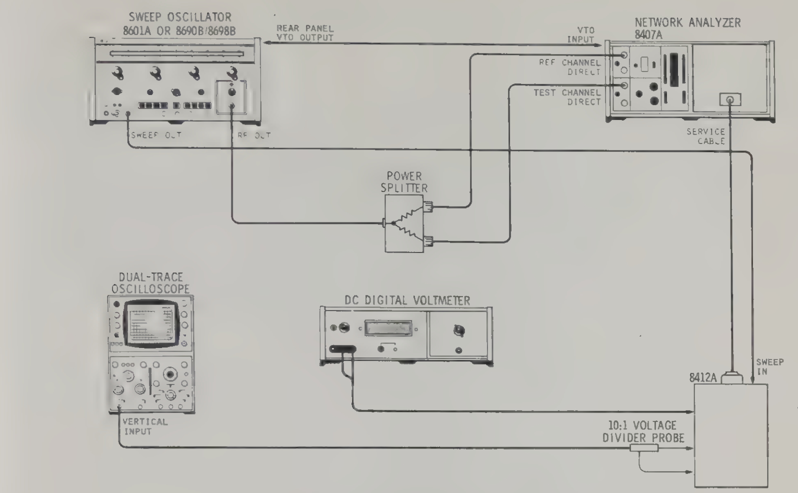
Set the switch to 10 DEG DIV and trace should be two small graticule lines above the center line.

Perform calibration of A phase detector and A3 mult plexer and vertical amplifier

Checkout Complete

Figure 7-4. Troubleshooting Tree

TEST SETUP WITH 8407A MAINFRAME



TEST SETUP WITH 8410A MAINFRAME

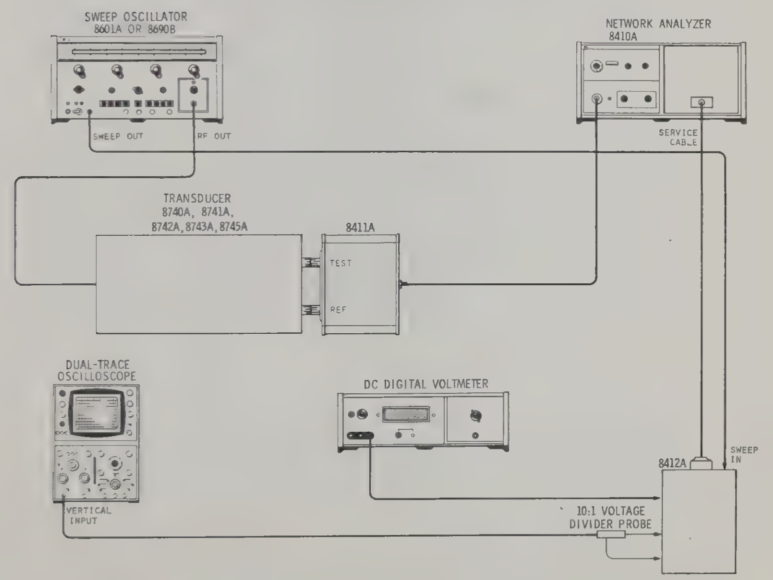


Figure 7-5. Test Setup for Troubleshooting Tree and Block Diagram

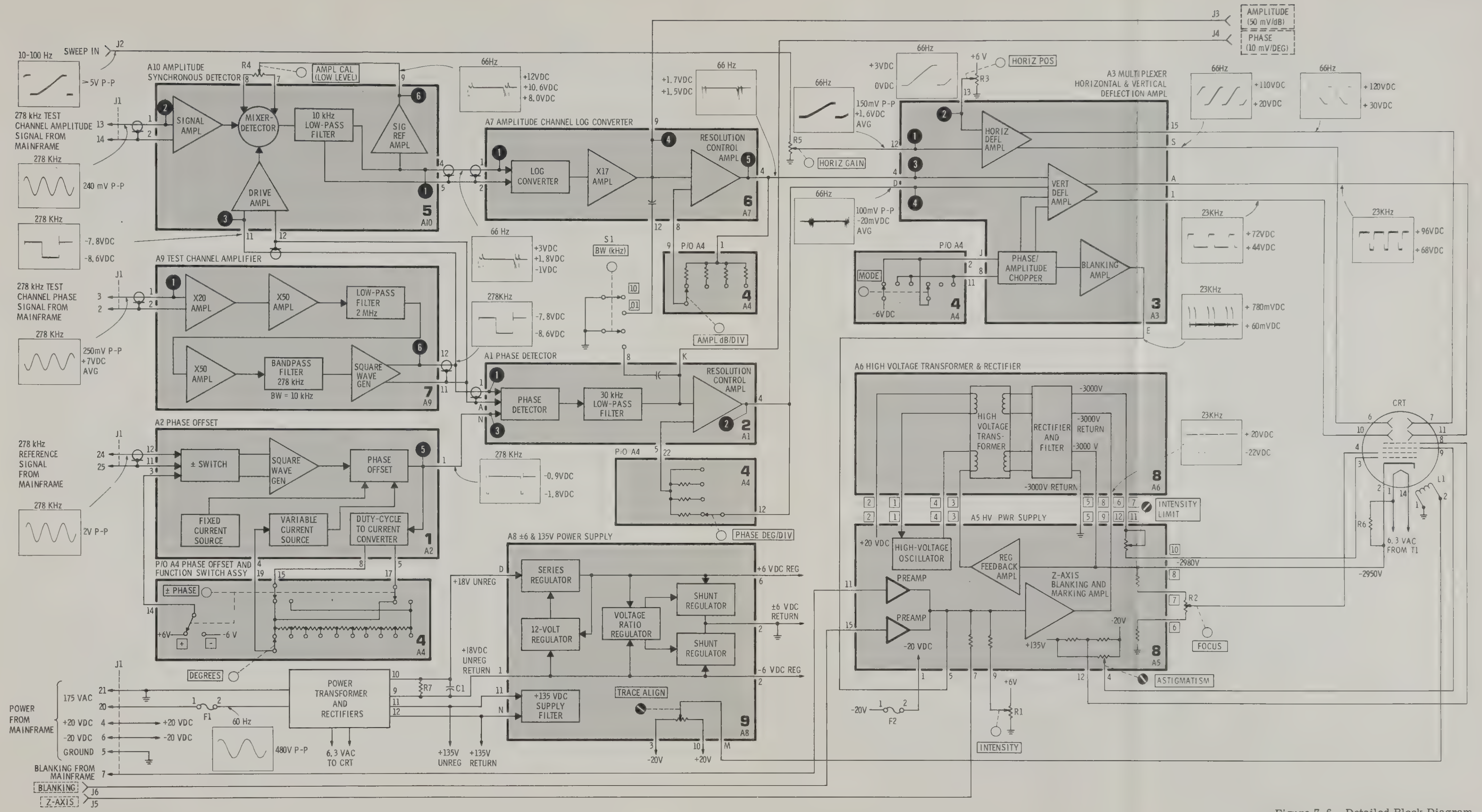


Figure 7-6. Detailed Block Diagram

1 THEORY FOR PHASE OFFSET A2

A2 PHASE OFFSET

The phase offset circuit delays the phase of the reference channel signal. The circuit consists of a 180-degree electronic switch and a phase delay system.

180-DEGREE SWITCH

The reference channel signal is applied through emitter follower Q1 to a double-pole, double throw electronic switch composed of Q2-Q5. The switch applies the signal and its ground to the inputs of differential amplifier Q6-Q8. When the signal and ground are reversed at the inputs, a 180-degree phase shift occurs. The positive PHASE OFFSET switch position applies ±6 Vdc to the bases of Q2-Q5, closing Q2 and Q5, and opening Q3 and Q4, so that the signal is applied to Q6 and the ground to Q7. A negative PHASE OFFSET switch position applies ±6 Vdc to Q2-Q5, reversing the switch.

SQUARING CIRCUIT

The signal is filtered at test point (1) and then it is squared by R-S flip-flop IC1-FF1. The Q output of IC1-FF1 at test point (3) is differentiated and applied to the reset input of IC1-FF2.

PHASE DELAY MULTIVIBRATOR

The phase delay through FF2 is the time between a positive going R (reset) input and a positive going Q output at test point (5). The Q output goes to its low state (-1.5 Vdc) when the R input crosses a -1.1 Vdc threshold in a positive direction. The Q output goes to its high state (zero Vdc) when the S (set) input crosses the -1.1 Vdc threshold in a positive direction. Hence the phase delay is the proportion of a period between reset and set inputs, when the Q output is in its low state.

PHASE DELAY TO VOLTAGE CONVERTER

During the time that the Q output of FF2 is low, the current in R31 is switched by Q10 and Q11A through R29 and R28. A current precisely equal to that in R31 and R34 is drawn through the phase offset resistors on A4. These resistors are each precisely 1/10 of R28 and R29. Each time one resistor is switched in or out, the proportion of time changes that the Q output of FF2 is low. This also changes the phase delay by 1/18. One eighteenth of 360 degrees is 20 degrees for each resistor. There are nine resistors so there is 180 degrees of possible phase delay. With the 180 degree (±) switch to select either 180-degree segment, a full 360 degrees of phase offset is possible. R28 is adjustable to set the current through R28 and R29. R30 is a fixed delay to match the test and reference phases but does not affect the switched offset.

FEEDBACK AMPLIFIER

The time for set input to follow reset input depends upon the rate at which current source Q14 charges capacitor C15. The current from Q14 is controlled by feedback amplifier Q12 and Q13. The feedback amplifier compares the voltage set by the resistors of the PHASE OFFSET DEGREES switch to a voltage at test point (6) which is proportional to the phase delay and drives Q14 so that the phase delay is correct.

FIXED CURRENT SOURCE

Q15 always passes enough current to C15 to be sure FF2 sets between resets. R44 adjusts this current.

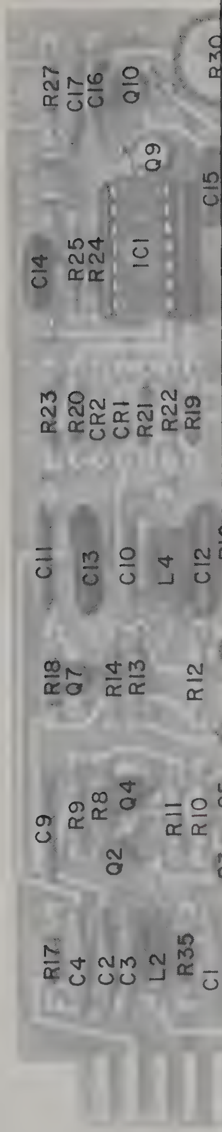
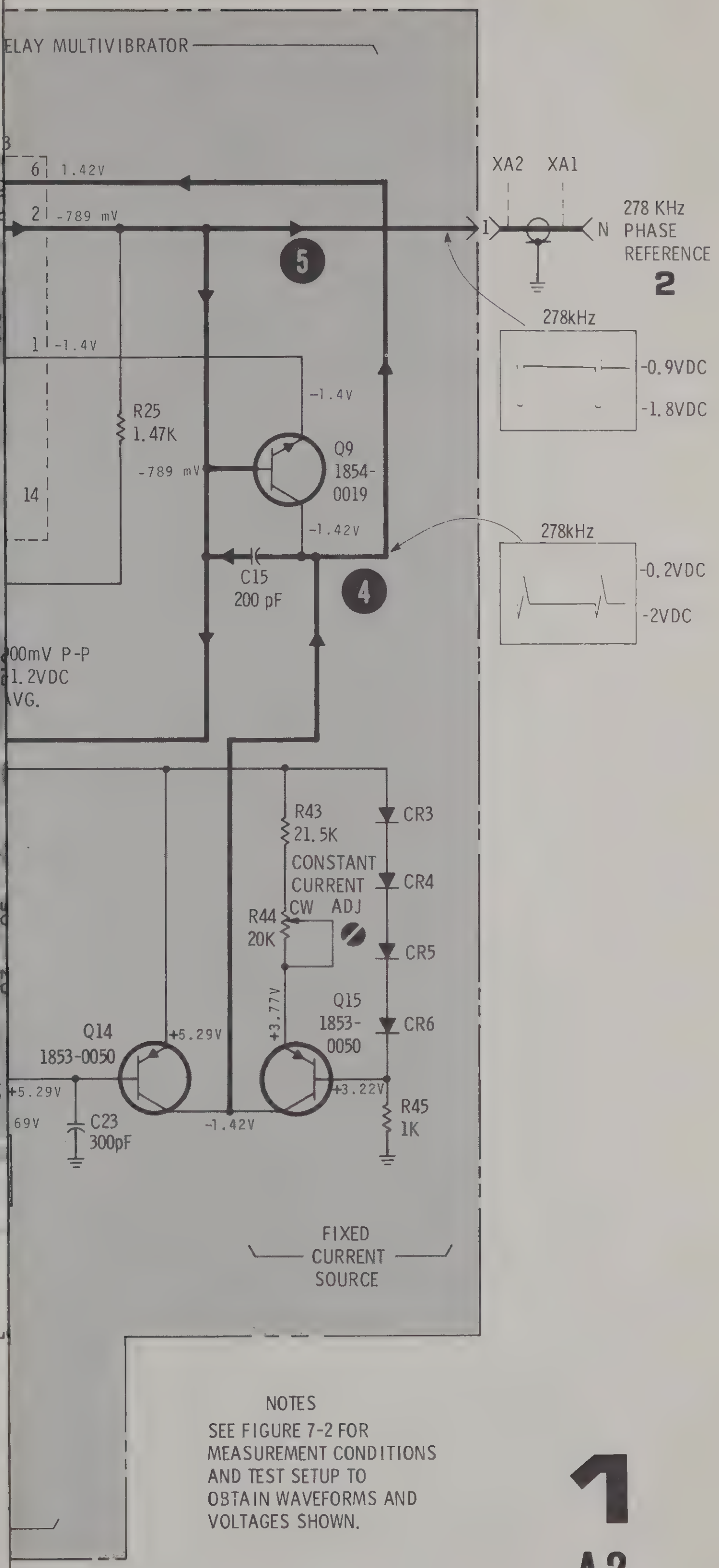


Figure 7-7. Parts L



NOTES
SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

Figure 7-8. Phase Offset A2, Schematic Diagram

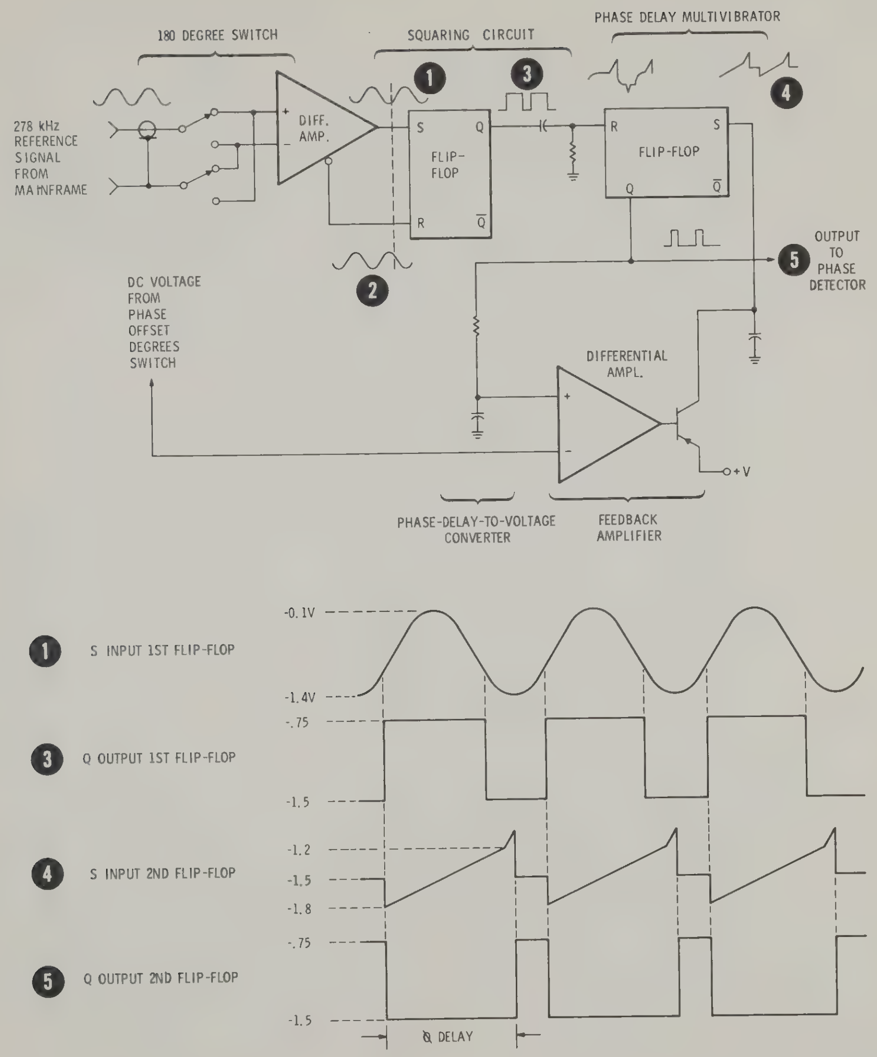


Figure 7-6a Phase Offset A2

1

THEORY FOR PHASE OFFSET A2

A2 PHASE OFFSET

The phase offset circuit delays the phase of the reference channel signal. The circuit consists of a 180-degree electronic switch and a phase delay system.

180-DEGREE SWITCH

The reference channel signal is applied through emitter follower Q1 to a double-pole, double throw electronic switch composed of Q2-Q5. The switch applies the signal and its ground to the inputs of differential amplifier Q6-Q8. When the signal and ground are reversed at the inputs, a 180-degree phase shift occurs. The positive PHASE OFFSET switch position applies ±6 Vdc to the bases of Q2-Q5, closing Q2 and Q5, and opening Q3 and Q4, so that the signal is applied to Q6 and the ground to Q7. A negative PHASE OFFSET switch position applies ±6 Vdc to Q2-Q5, reversing the switch.

SQUARING CIRCUIT

The signal is filtered at test point (1) and then it is squared by R-S flip-flop IC1-FF1. The Q output of IC1-FF1 at test point (3) is differentiated and applied to the reset input of IC1-FF2.

PHASE DELAY MULTIVIBRATOR

The phase delay through FF2 is the time between a positive going R (reset) input and a positive going Q output at test point (5). The Q output goes to its low state (-1.5 Vdc) when the R input crosses a -1.1 Vdc threshold in a positive direction. The Q output goes to its high state (zero Vdc) when the S (set) input crosses the -1.1 Vdc threshold in a positive direction. Hence the phase delay is the proportion of a period between reset and set inputs, when the Q output is in its low state.

PHASE DELAY TO VOLTAGE CONVERTER

During the time that the Q output of FF2 is low, the current in R31 is switched by Q10 and Q11A through R29 and R28. A current precisely equal to that in R31 and R34 is drawn through the phase offset resistors on A4. These resistors are each precisely 1/10 of R28 and R29. Each time one resistor is switched in or out, the proportion of time changes that the Q output of FF2 is low. This also changes the phase delay by 1/18. One eighteenth of 360 degrees is 20 degrees for each resistor. There are nine resistors so there is 180 degrees of possible phase delay. With the 180 degree (±) switch to select either 180-degree segment, a full 360 degrees of phase offset is possible. R28 is adjustable to set the current through R28 and R29. R30 is a fixed delay to match the test and reference phases but does not affect the switched offset.

FEEDBACK AMPLIFIER

The time for set input to follow reset input depends upon the rate at which current source Q14 charges capacitor C15. The current from Q14 is controlled by feedback amplifier Q12 and Q13. The feedback amplifier compares the voltage set by the resistors of the PHASE OFFSET DEGREES switch to a voltage at test point (6) which is proportional to the phase delay and drives Q14 so that the phase delay is correct.

FIXED CURRENT SOURCE

Q15 always passes enough current to C15 to be sure FF2 sets between resets. R44 adjusts this current.

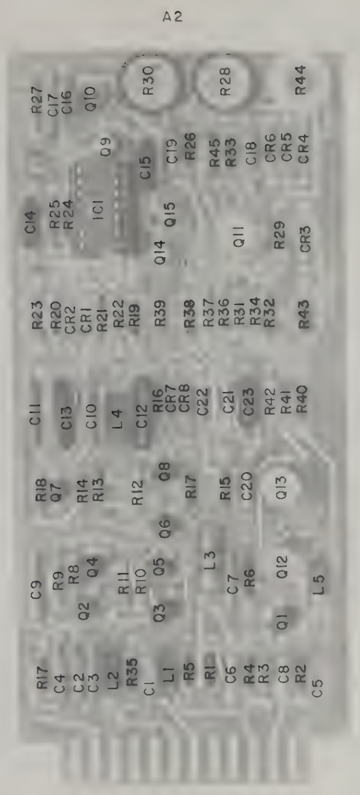
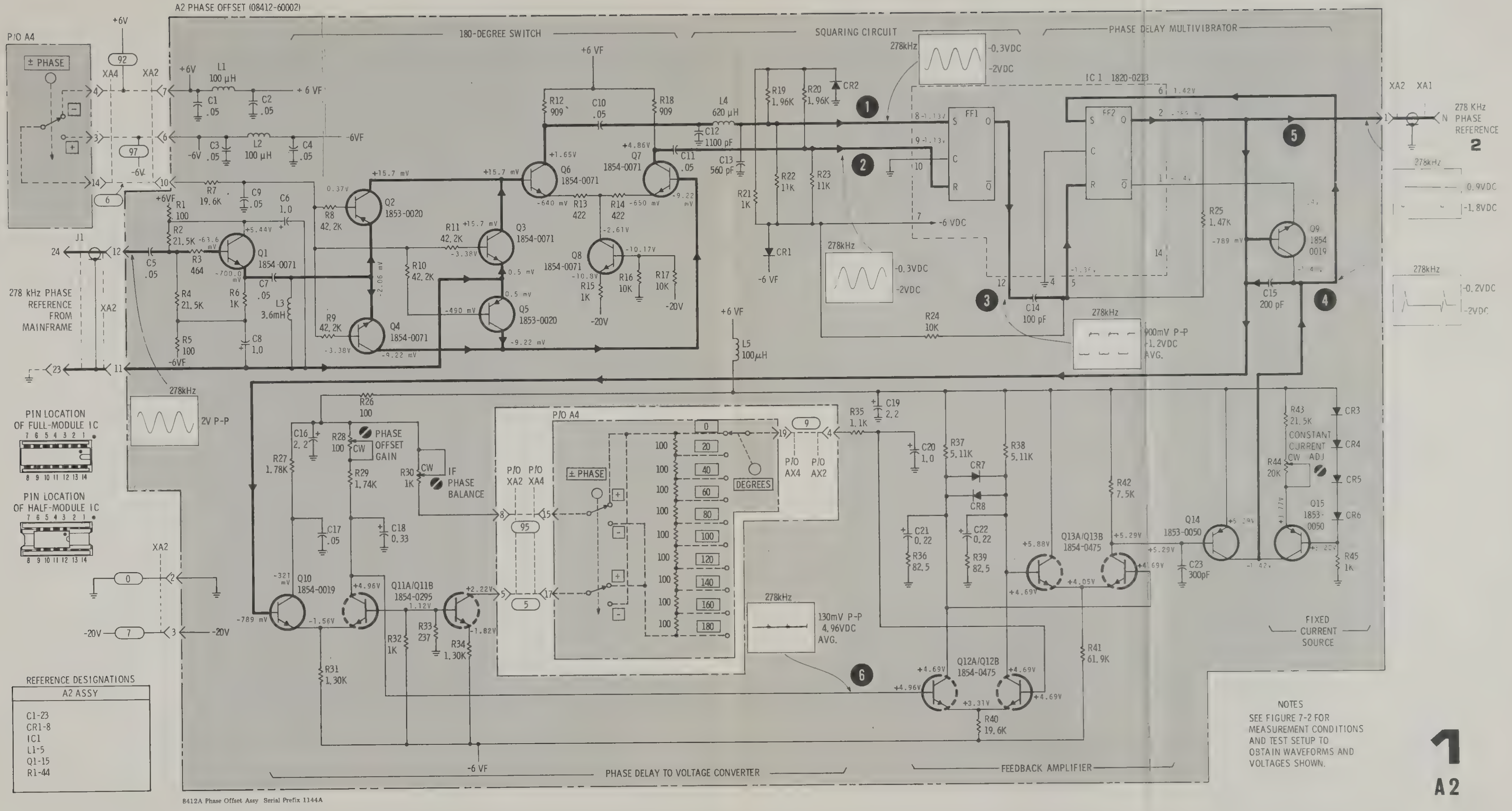

A2
R27 C17 C16 Q10 R30 R28 R44
Q9 C15 C19 R26 R45 R33 C18 CR6 CR5 CR4
C14 R25 R24 IC1 Q15 Q14 Q11 R29 CR3
R23 R20 CR2 CR1 R21 R22 R19 R39 R38 R37 R36 R31 R34 R32 R43
C11 C13 C10 L4 C12 R16 CR7 CR8 C22 C21 C23 R42 R41 R40
R18 Q7 R14 R13 R12 Q8 R17 R15 C20 Q13
C9 R9 R8 Q4 Q2 R11 R10 Q5 Q3 Q6 L3 C7 R6 Q12 Q1 L5
R17 C4 C2 C3 L2 R35 C1 L1 R5 R1 C6 R4 R3 C8 R2 C5

Figure 7-7. Parts Location for Phase Offset A2



REFERENCE DESIGNATIONS

A2 ASSY

C1-23
CR1-8
IC1
L1-5
Q1-15
R1-44

NOTES

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

1
A2

Figure 7-8. Phase Offset A2, Schematic Diagram

2 THEORY FOR PHASE DETECTOR A1

PHASE DETECTOR

The test phase signal from A9 is applied at test point (1) and passes through a differentiating network to one input of J-K flip-flop IC1 that is used as a bi-stable multivibrator. The reference phase signal from A2 is applied at test point (3) to the other input of IC1. The output of IC1 at test point (4) is a square wave, going up on a reference signal zero crossing and down on a phase signal zero crossing. The symmetry of the square wave is an indication of the phase difference between channels.

PHASE-TO-VOLTAGE CONVERTER

The square wave symmetry is converted to a dc voltage at test point (5) as follows. The current from constant current source Q4 is switched through Q2 only when test point (4) is down. This switched current is filtered by the L-C network (C6, C7, and L5). Current source Q3 is adjusted by R6 to have exactly half the current in Q4. With a symmetrical square wave, the filtered current through Q2 and the current through Q3 are equal and the voltage at test point (5) is zero because there is no current flowing in R17 and R18. (A symmetrical square wave means that the reference and test signals are in phase because a constant 180° phase shift has been added to the test phase in A9.) When the square wave is not symmetrical, current through R17 and R18 gives a voltage calibrated by R18, so that 10 mV is equivalent to one degree of phase difference. This dc voltage is applied to the rear panel PHASE 10 mV/DEG output. The bandwidth is changed by the BW (kHz) switch that grounds pin 8 so that C8 and C9 apply 100 Hz low-pass filtering at the junction of C8, R17, R20 and R21.

RESOLUTION CONTROL

A PHASE DEG/DIV switch changes the feedback resistor from output to input of IC2 setting the gain of the phase channel. This switches the resolution of the CRT phase display.

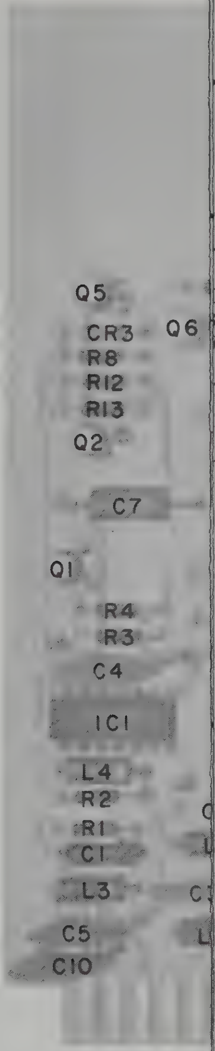
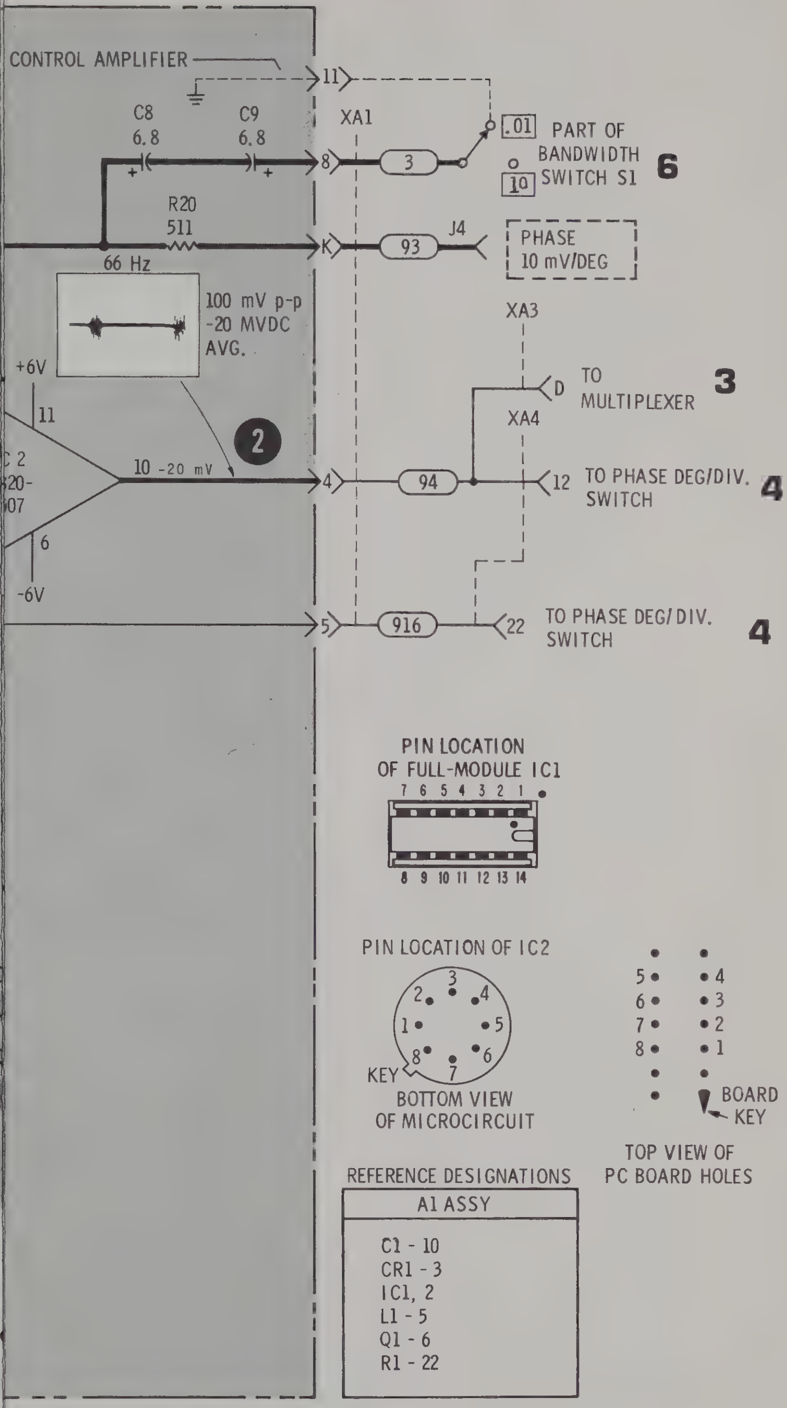


Figure 7-9. Parts Lo



2

A1

Figure 7-10. Phase Detector A1, Schematic Diagram

2 THEORY FOR PHASE DETECTOR A1

PHASE DETECTOR

The test phase signal from A9 is applied at test point (1) and passes through a differentiating network to one input of J-K flip-flop IC1 that is used as a bi-stable multivibrator. The reference phase signal from A2 is applied at test point (3) to the other input of IC1. The output of IC1 at test point (4) is a square wave, going up on a reference signal zero crossing and down on a phase signal zero crossing. The symmetry of the square wave is an indication of the phase difference between channels.

PHASE-TO-VOLTAGE CONVERTER

The square wave symmetry is converted to a dc voltage at test point (5) as follows. The current from constant current source Q4 is switched through Q2 only when test point (4) is down. This switched current is filtered by the L-C network (C6, C7, and L5). Current source Q3 is adjusted by R6 to have exactly half the current in Q4. With a symmetrical square wave, the filtered current through Q2 and the current through Q3 are equal and the voltage at test point (5) is zero because there is no current flowing in R17 and R18. (A symmetrical square wave means that the reference and test signals are in phase because a constant 180° phase shift has been added to the test phase in A9.) When the square wave is not symmetrical, current through R17 and R18 gives a voltage calibrated by R18, so that 10 mV is equivalent to one degree of phase difference. This dc voltage is applied to the rear panel PHASE 10 mV/DEG output. The bandwidth is changed by the BW (kHz) switch that grounds pin 8 so that C8 and C9 apply 100 Hz low-pass filtering at the junction of C8, R17, R20 and R21.

RESOLUTION CONTROL

A PHASE DEG/DIV switch changes the feedback resistor from output to input of IC2 setting the gain of the phase channel. This switches the resolution of the CRT phase display.

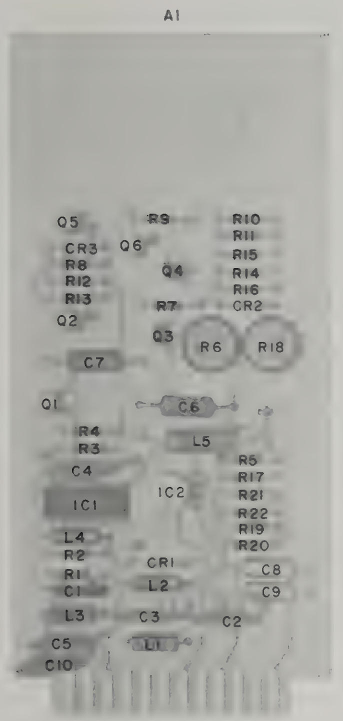
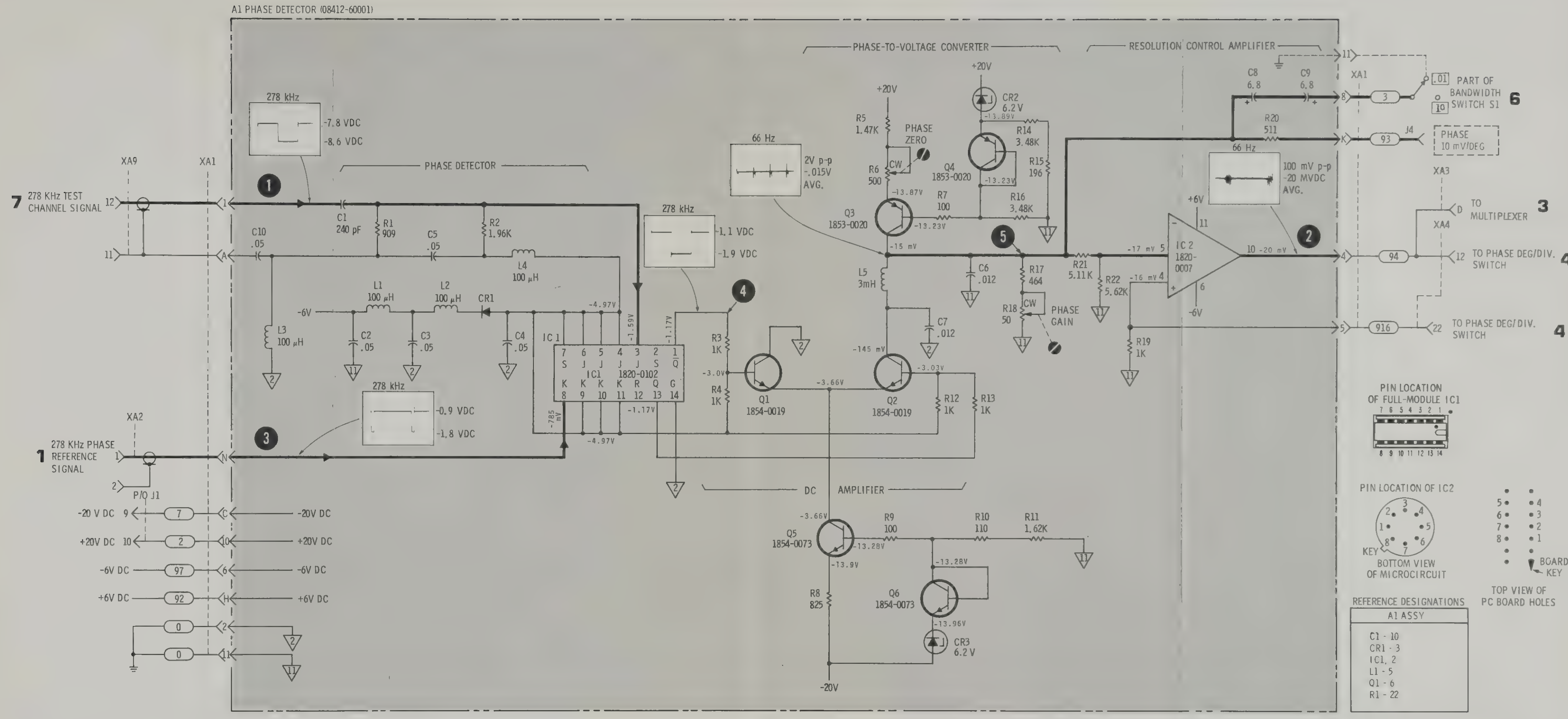


Figure 7-9. Parts Location for Phase Detector A1



8412A Phase Detector Serial Prefix 1144A

NOTE

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

2

A1

Figure 7-10. Phase Detector A1, Schematic Diagram

3 THEORY FOR MULTIPLEXER AND DEFLECTION AMPLIFIER A3

CRT DEFLECTION

The phase information from phase detector A1 and the amplitude information from log converter A7 are multiplexed by a free-running multivibrator, Q13 and Q14. The two multivibrator outputs alternately switch Q2 and Q3 current sources, which alternately operate the amplitude (Q7 and Q8) and the phase (Q9 and Q10) differential amplifiers. The differential amplifiers operate in cascade with Q1 and Q4 to produce the deflection voltages. VERT. DEFL. ADJ. R23 calibrates the vertical deflection gain of the circuit to match the CRT. Adjustments R24 and R25 position the amplitude and phase traces at the center of the screen. The horizontal deflection amplifier is Q6 and Q7.

CHOPPER

In DUAL position, the multivibrator is allowed to operate free-running by returning both bases to -6 Vdc. However, in AMPL (amplitude) position, -6 Vdc is only applied to the base of Q14, turning it on, turning Q13 off, and holding them in that state. This turns Q2 on and Q3 off, allowing only the amplitude signal to be applied to the CRT. When the MODE switch is in PHASE position, -6 Vdc is applied only to the base of Q13, turning Q13 on and Q14 off. This allows only the phase signal to be applied to the CRT.

CHOPPER BLANKING

The multivibrator outputs are also coupled to blanking amplifiers Q11 and Q12, which provides the chopper blanking signal to high-voltage power supply A5. This blanks the screen on transition between amplitude and phase.

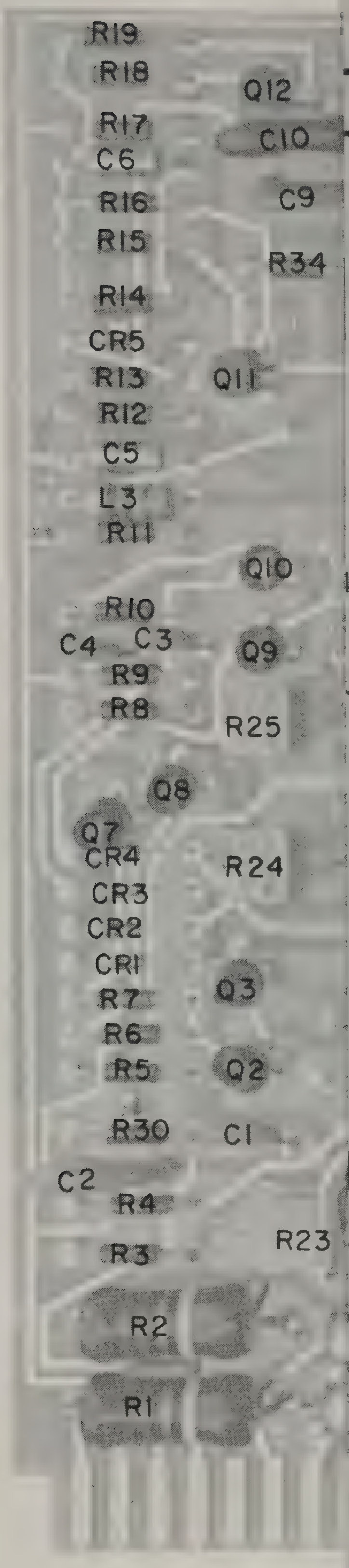
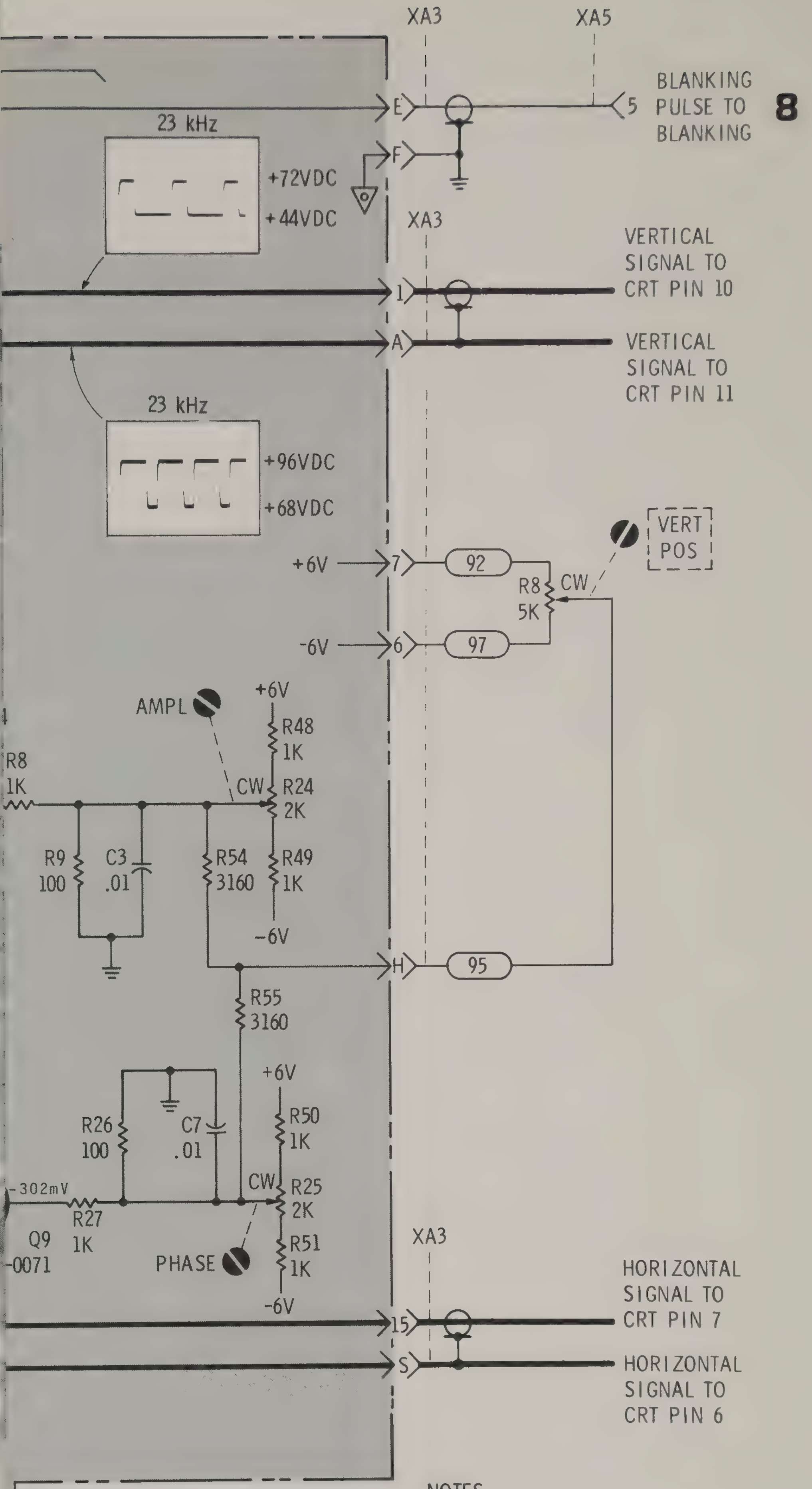


Figure 7-11. Parts
Deflecti



REFERENCE DESIGNATIONS

A3 ASSY
C1 - 13 CR1 - 6 L1 - 3 Q1 - 15 R1 - 55
CHASSIS
R3, 5, 8

NOTES

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

3

A3

Figure 7-12. Multiplexer and Deflection Amplifier A3, Schematic Diagram

3 THEORY FOR MULTIPLEXER AND DEFLECTION AMPLIFIER A3

CRT DEFLECTION

The phase information from phase detector A1 and the amplitude information from log converter A7 are multiplexed by a free-running multivibrator, Q13 and Q14. The two multivibrator outputs alternately switch Q2 and Q3 current sources, which alternately operate the amplitude (Q7 and Q8) and the phase (Q9 and Q10) differential amplifiers. The differential amplifiers operate in cascade with Q1 and Q4 to produce the deflection voltages. VERT. DEFL. ADJ. R23 calibrates the vertical deflection gain of the circuit to match the CRT. Adjustments R24 and R25 position the amplitude and phase traces at the center of the screen. The horizontal deflection amplifier is Q6 and Q7.

CHOPPER

In DUAL position, the multivibrator is allowed to operate free-running by returning both bases to -6 Vdc. However, in AMPL (amplitude) position, -6 Vdc is only applied to the base of Q14, turning it on, turning Q13 off, and holding them in that state. This turns Q2 on and Q3 off, allowing only the amplitude signal to be applied to the CRT. When the MODE switch is in PHASE position, -6 Vdc is applied only to the base of Q13, turning Q13 on and Q14 off. This allows only the phase signal to be applied to the CRT.

CHOPPER BLANKING

The multivibrator outputs are also coupled to blanking amplifiers Q11 and Q12, which provides the chopper blanking signal to high-voltage power supply A5. This blanks the screen on transition between amplitude and phase.

A3

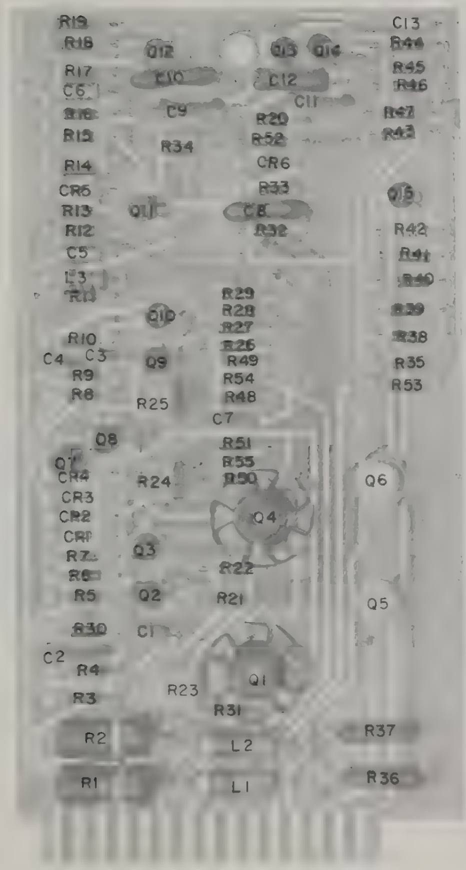


Figure 7-11. Parts Location for Multiplexer and Deflection Amplifier A3

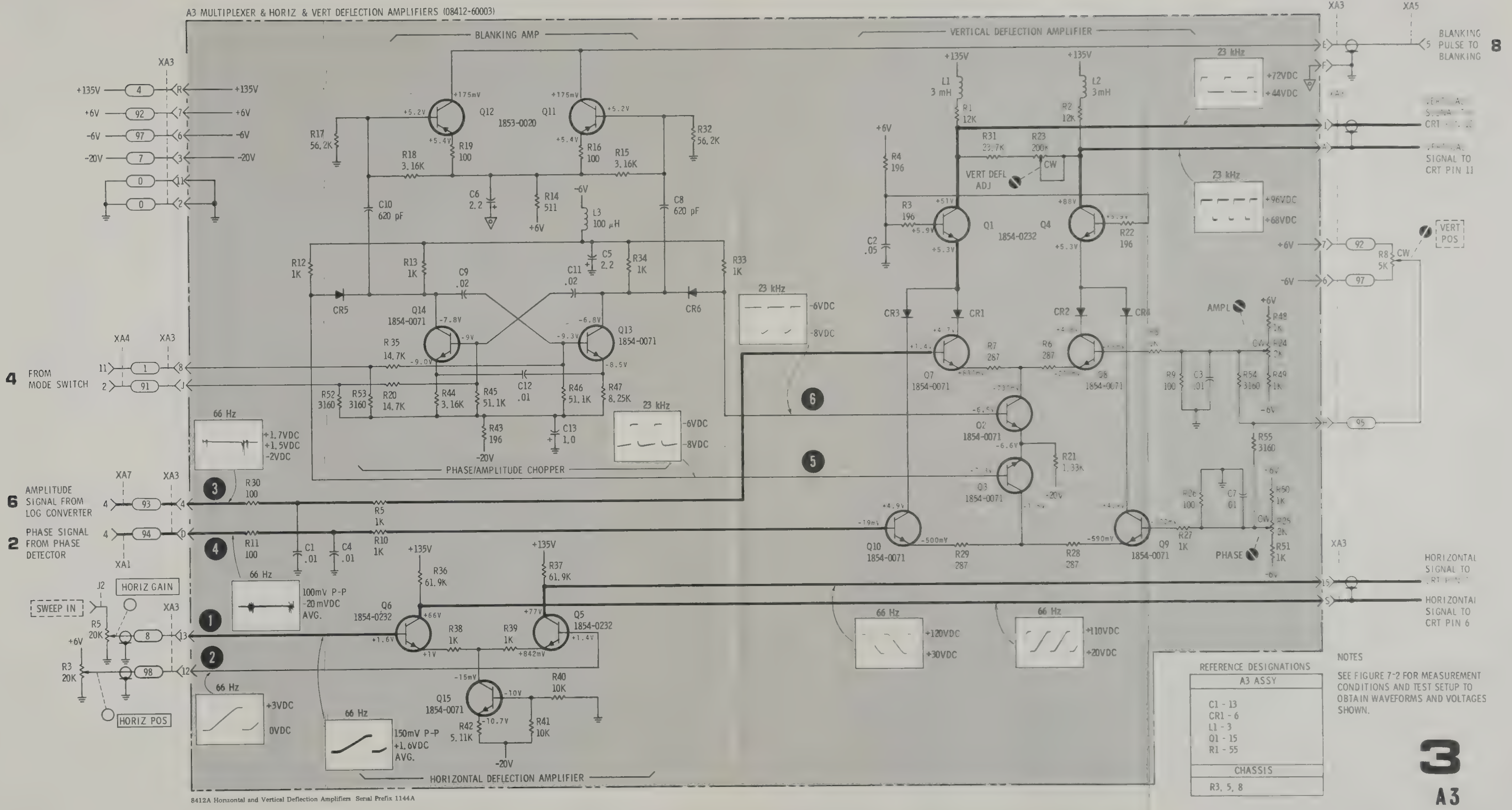


Figure 7-12. Multiplexer and Deflection Amplifier A3, Schematic Diagram

4 THEORY FOR PHASE OFFSET AND FUNCTION SWITCH A4

PHASE OFFSET SWITCH

The two phase offset switches work together to select the desired phase offset. The phase offset polarity is selected by the ± phase offset switch and the phase offset magnitude by the PHASE OFFSET DEGREES switch.

AMPL DB/DIV SWITCH

The AMPL DB/DIV switch controls the display amplitude resolution by supplying the feedback resistor for A7IC3.

PHASE DEG/DIV SWITCH

The PHASE DEG/DIV switch controls the display phase resolution by supplying the feedback resistor for A1IC2.

MODE SWITCH

The MODE switch controls the multivibrator-chopper in A3.

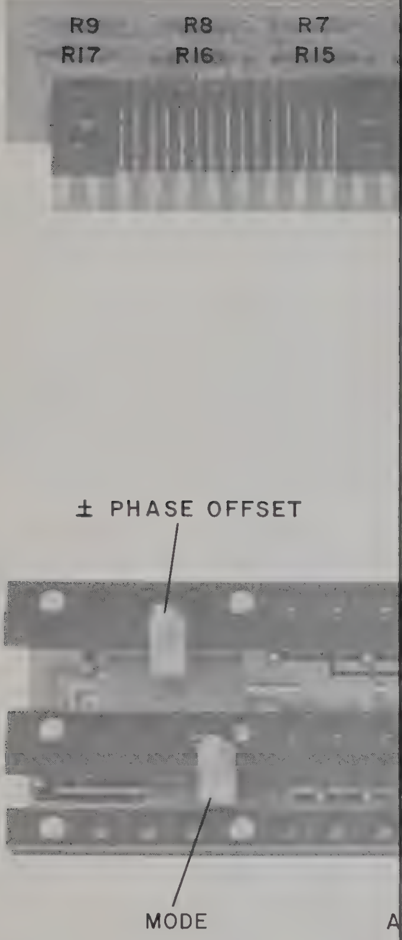


Figure 7-13. Parts Location fo

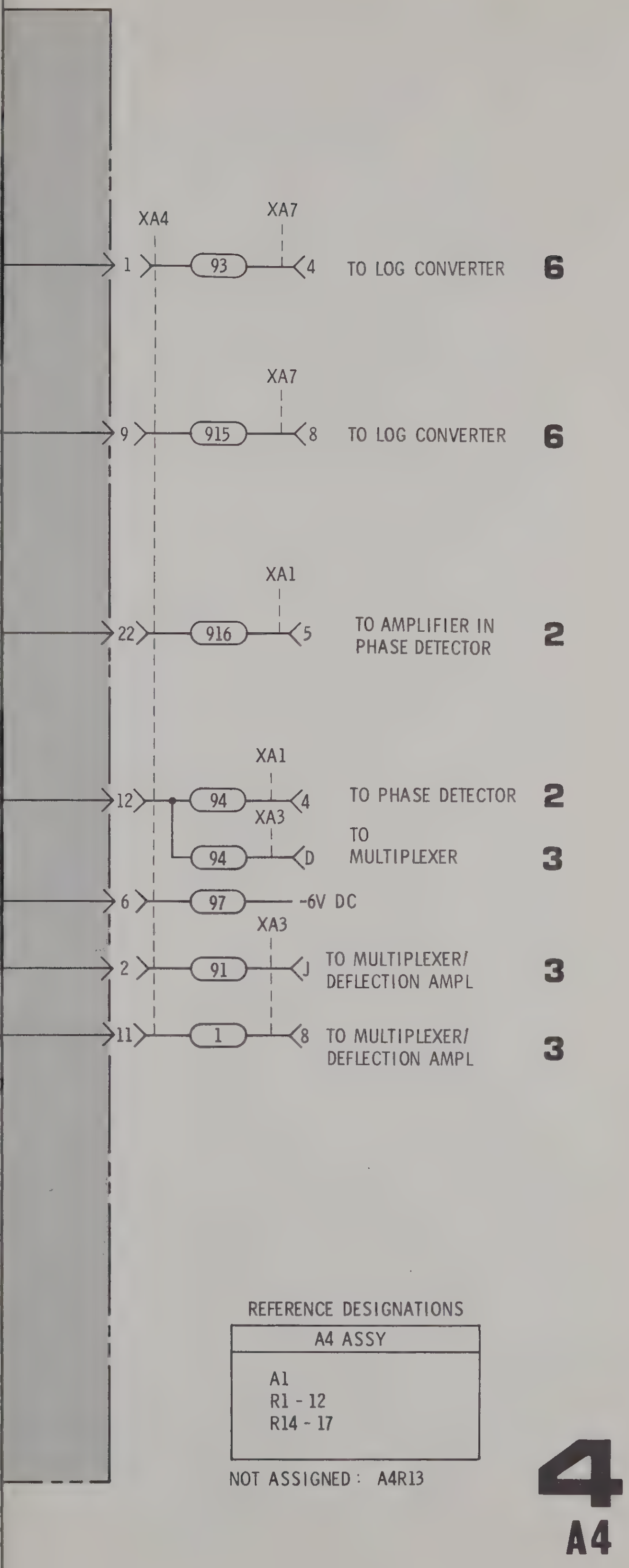


Figure 7-14. Phase Offset and Function Switch A4, Schematic Diagram

4 THEORY FOR PHASE OFFSET AND FUNCTION SWITCH A4

PHASE OFFSET SWITCH

The two phase offset switches work together to select the desired phase offset. The phase offset polarity is selected by the ± phase offset switch and the phase offset magnitude by the PHASE OFFSET DEGREES switch.

AMPL DB/DIV SWITCH

The AMPL DB/DIV switch controls the display amplitude resolution by supplying the feedback resistor for A7IC3.

PHASE DEG/DIV SWITCH

The PHASE DEG/DIV switch controls the display phase resolution by supplying the feedback resistor for A1IC2.

MODE SWITCH

The MODE switch controls the multivibrator-chopper in A3.

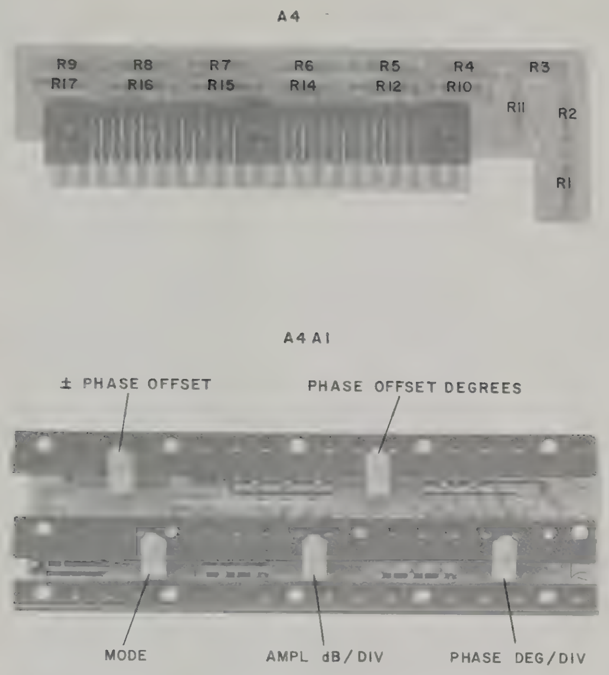


Figure 7-13. Parts Location for Phase Offset and Function Switch A4

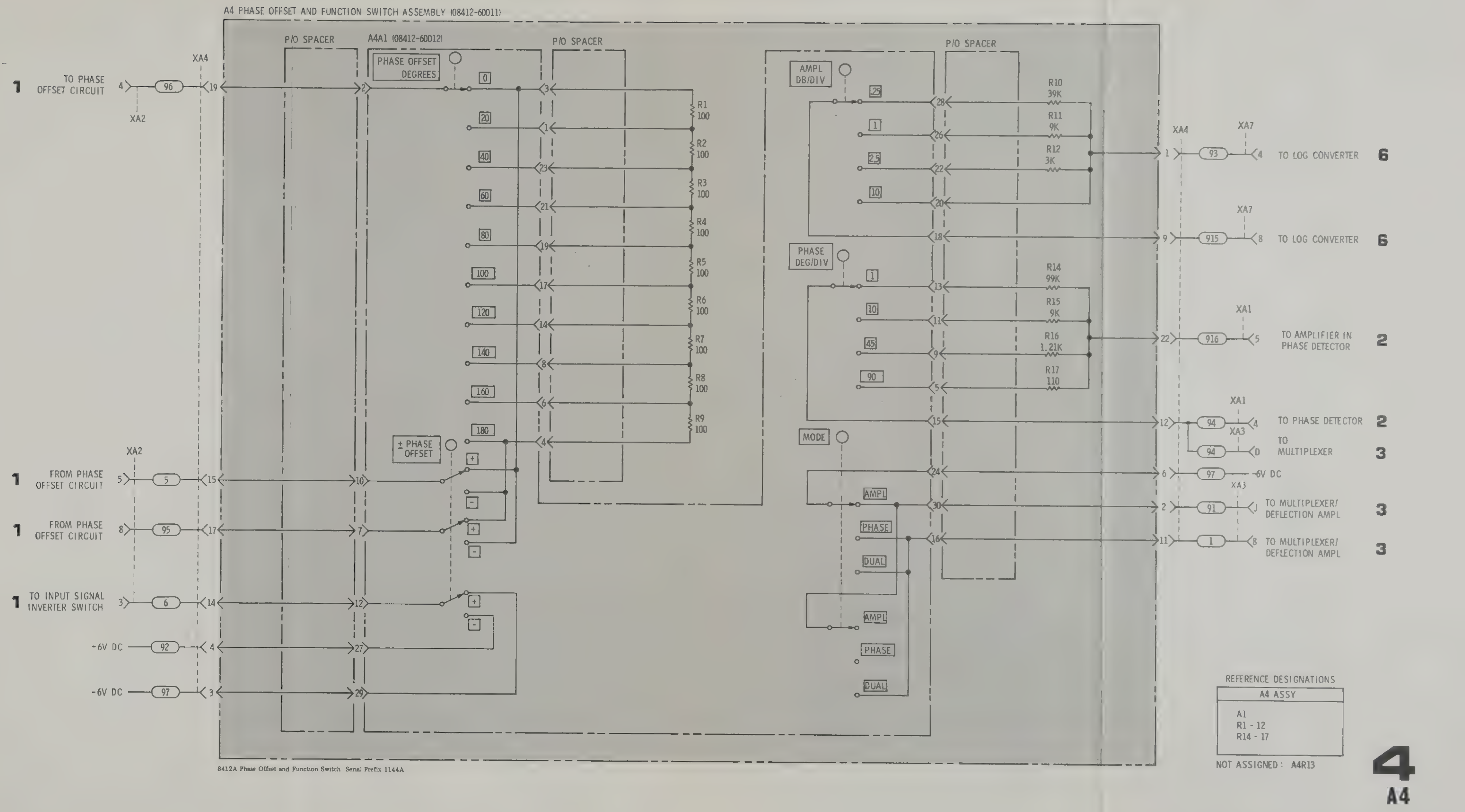


Figure 7-14. Phase Offset and Function Switch A4. Schematic Diagram

5 THEORY FOR AMPLITUDE SYNCHRONOUS DETECTOR A10

INPUT AMPLIFIER

The 278 kHz test channel amplitude signal at test point (2) is amplified through Q1 and Q2 and applied to the amplitude detector input at the bases of Q4A and Q4B.

DRIVE AMPLIFIER

The amplitude detector drive signal from A9 (test point3) is amplified through Q6A and Q6B and applied to the amplitude detector at the bases of Q7-Q10. The drive signal is synchronous with the test channel amplitude signal because both are derived from the test channel.

MIXER DETECTOR

The drive signal switches Q7-Q10 such that the current through R34 and R40 is the full wave rectified input amplitude signal. Front panel AMPL CAL (LOW LEVEL) control R10 balances the circuit so that for zero-amplitude signal input, the voltages at test points (1) and (7) are equal.

GROUND REFERENCING

The feedback circuit composed of IC1, Q11, and Q12 maintains the output voltage referenced to ground.

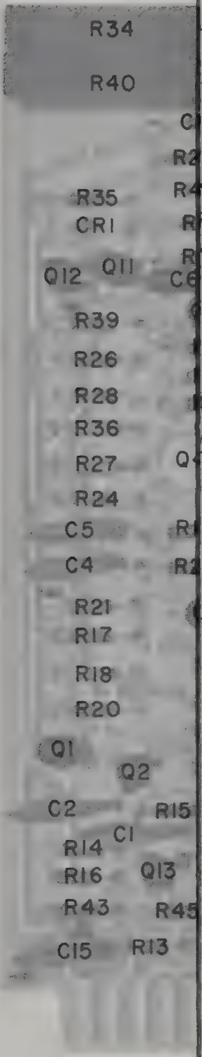
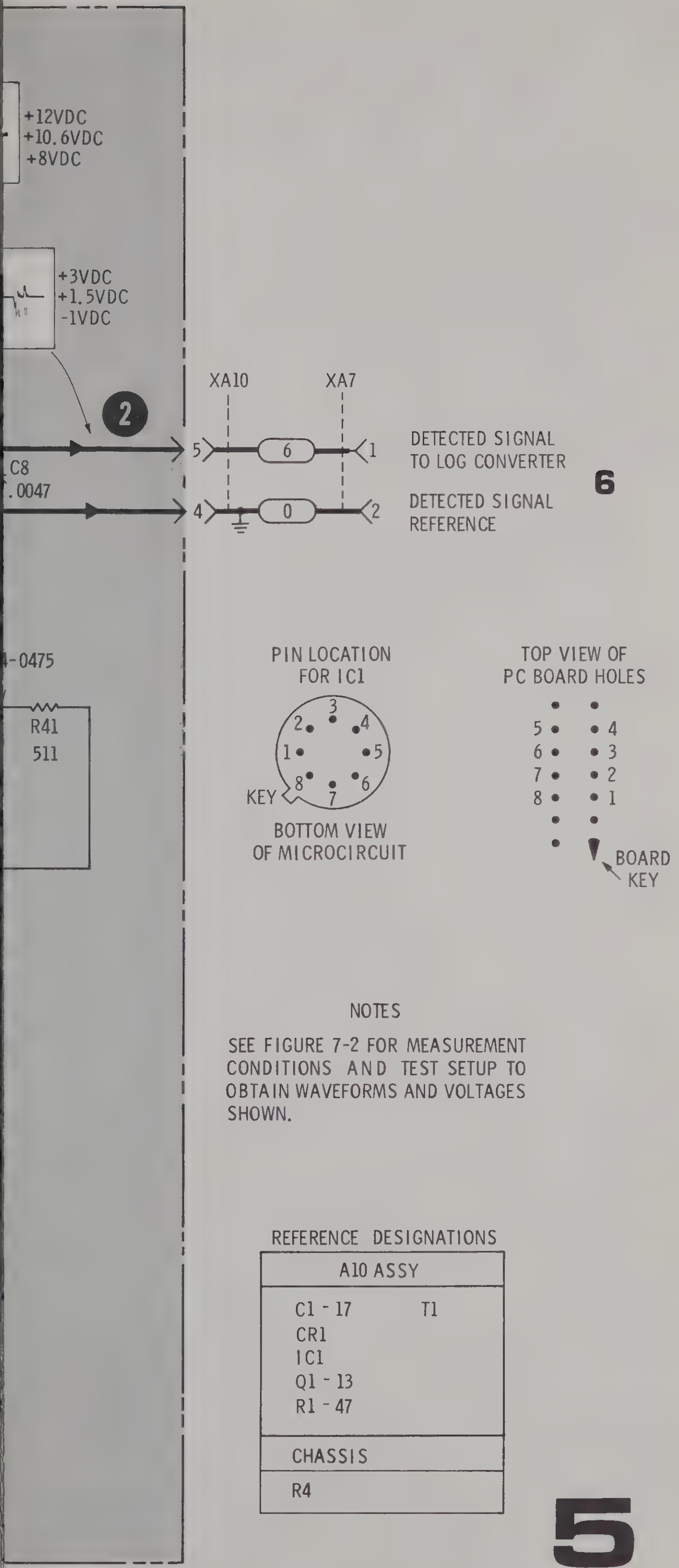


Figure 7-15. Par
Synchron



NOTES

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

REFERENCE DESIGNATIONS

A10 ASSY	
C1 - 17 CR1 IC1 Q1 - 13 R1 - 47	T1
CHASSIS	
R4	

Figure 7-16. Amplitude Synchronous Detector A10, Schematic Diagram

5 THEORY FOR AMPLITUDE SYNCHRONOUS DETECTOR A10

INPUT AMPLIFIER

The 278 kHz test channel amplitude signal at test point (2) is amplified through Q1 and Q2 and applied to the amplitude detector input at the bases of Q4A and Q4B.

DRIVE AMPLIFIER

The amplitude detector drive signal from A9 (test point3) is amplified through Q6A and Q6B and applied to the amplitude detector at the bases of Q7-Q10. The drive signal is synchronous with the test channel amplitude signal because both are derived from the test channel.

MIXER DETECTOR

The drive signal switches Q7-Q10 such that the current through R34 and R40 is the full wave rectified input amplitude signal. Front panel AMPL CAL (LOW LEVEL) control R10 balances the circuit so that for zero-amplitude signal input, the voltages at test points (1) and (7) are equal.

GROUND REFERENCING

The feedback circuit composed of IC1, Q11, and Q12 maintains the output voltage referenced to ground.

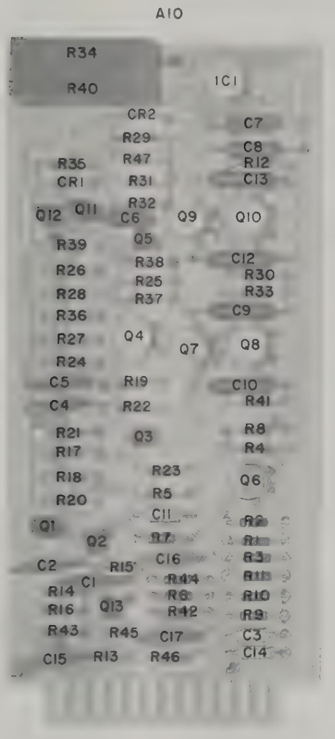
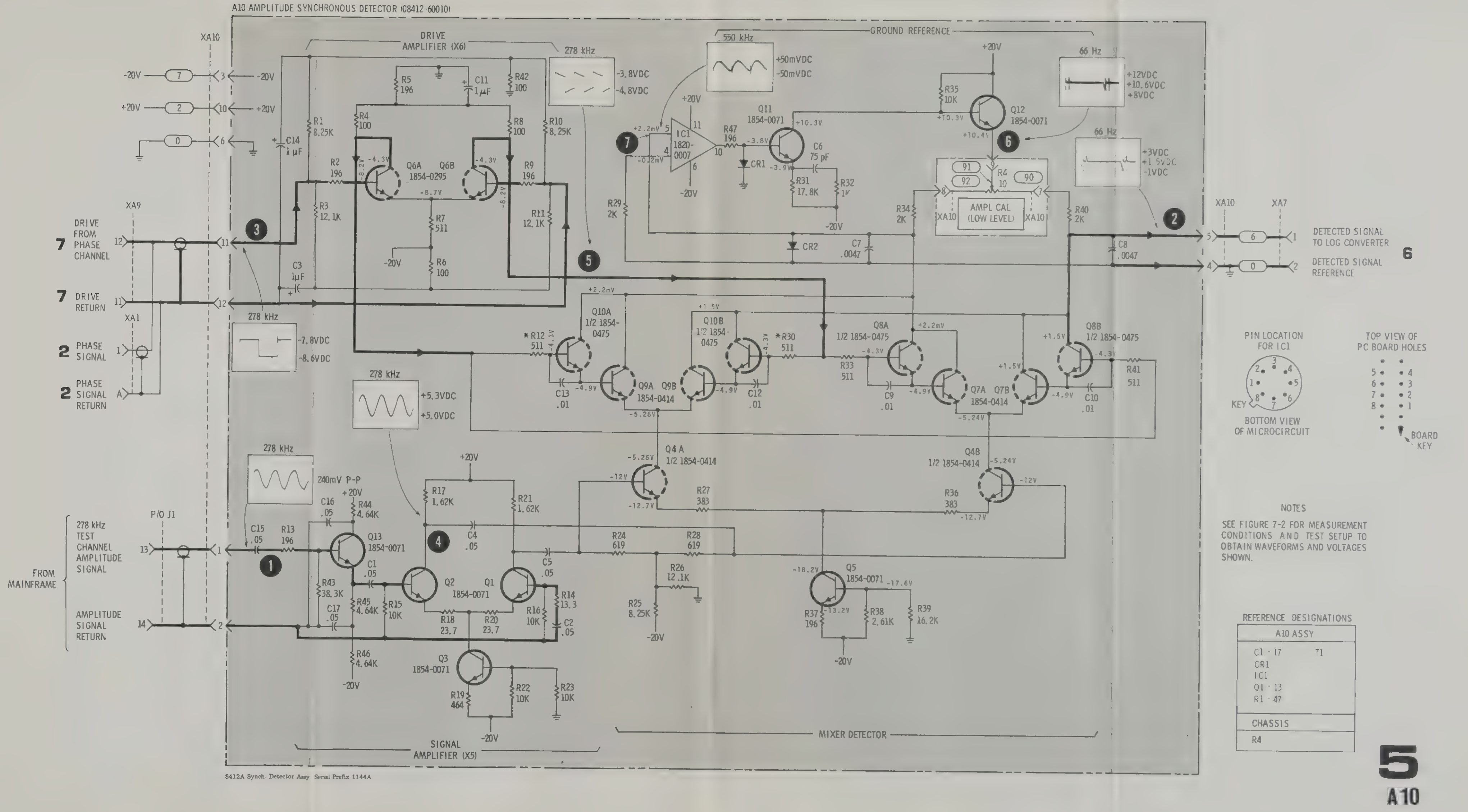


Figure 7-15. Parts Location for Amplitude Synchronous Detector A10



8412A Synch. Detector Assy Serial Prefix 1144A

NOTES

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

REFERENCE DESIGNATIONS

A10 ASSY	
C1 - 17 CR1 IC1 Q1 - 13 R1 - 47	T1
CHASSIS	
R4	

5

A10

Figure 7-16. Amplitude Synchronous Detector A10, Schematic Diagram

6

THEORY FOR LOG CONVERTER A7

LOG CONVERTER

The log circuit consists of transistor Q1A and operational amplifier IC1. The voltage at test point (1) and virtual ground at IC1 pin 4 causes a current. This current must be equal to the collector current of Q1A, since no input current flows into the operational amplifier. The operational amplifier maintains the base-to-emitter voltage of Q1A so that the correct collector current is maintained. Since the base-to-emitter voltage of Q1A is proportional to the log of the collector current, the output voltage is the log of the input voltage.

VOLTAGE FOLLOWER

Q1B shifts voltage level so that at test point (2), the log output operates about ground at approximately 30 mV output for X3 input at test point (1). R7 sets the correct amplitude center level. IC2 is a voltage follower. IC4 is a fixed gain amplifier with adjustment R14 so that a 1 dB input change produces 50 mV output. The dc voltage is brought to the rear panel AMPLITUDE (50 mV/dB) connector. The BW (kHz) switch connects a capacitor from IC3, pin 5 to ground, which forms a 100 Hz low-pass filter.

RESOLUTION CONTROL

The feedback resistor between the output and the input of IC4 sets the gain of the amplitude channel. The value of this resistance is changed by the AMPL dB/DIV switch, thus changing the resolution of the CRT display.

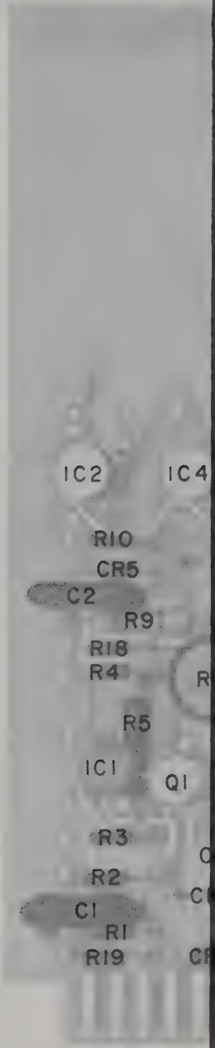


Figure 7-17. Parts L
Log C

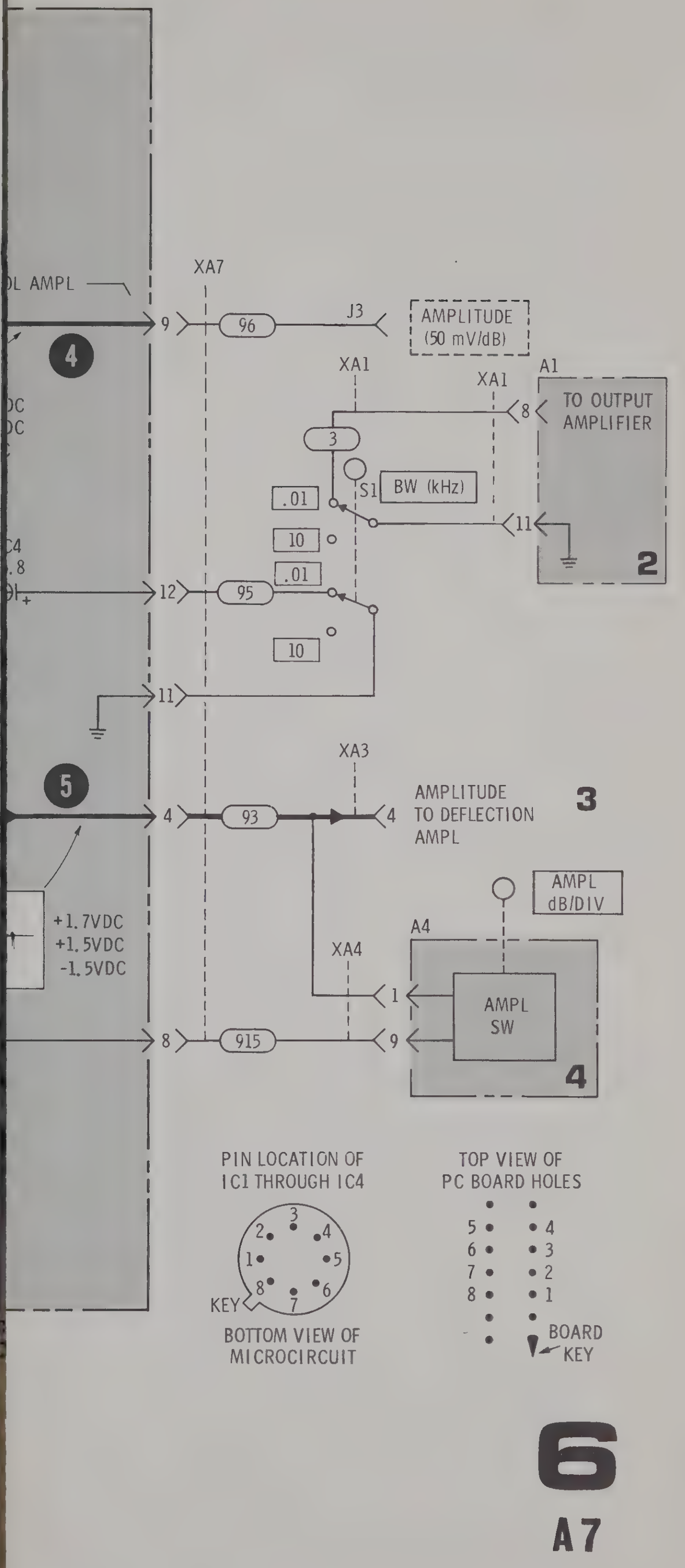


Figure 7-18. Amplitude Channel Log Converter A7, Schematic Diagram

6 THEORY FOR LOG CONVERTER A7

LOG CONVERTER

The log circuit consists of transistor Q1A and operational amplifier IC1. The voltage at test point (1) and virtual ground at IC1 pin 4 causes a current. This current must be equal to the collector current of Q1A, since no input current flows into the operational amplifier. The operational amplifier maintains the base-to-emitter voltage of Q1A so that the correct collector current is maintained. Since the base-to-emitter voltage of Q1A is proportional to the log of the collector current, the output voltage is the log of the input voltage.

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Q1B shifts voltage level so that at test point (2), the log output operates about ground at approximately 30 mV output for X3 input at test point (1). R7 sets the correct amplitude center level. IC2 is a voltage follower. IC4 is a fixed gain amplifier with adjustment R14 so that a 1 dB input change produces 50 mV output. The dc voltage is brought to the rear panel AMPLITUDE (50 mV/dB) connector. The BW (kHz) switch connects a capacitor from IC3, pin 5 to ground, which forms a 100 Hz low-pass filter.

RESOLUTION CONTROL

The feedback resistor between the output and the input of IC4 sets the gain of the amplitude channel. The value of this resistance is changed by the AMPL dB/DIV switch, thus changing the resolution of the CRT display.

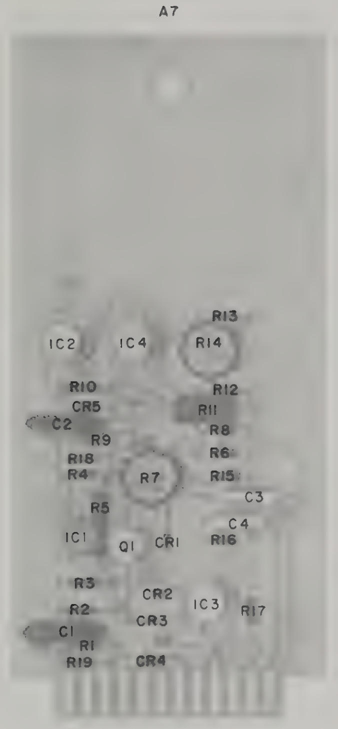
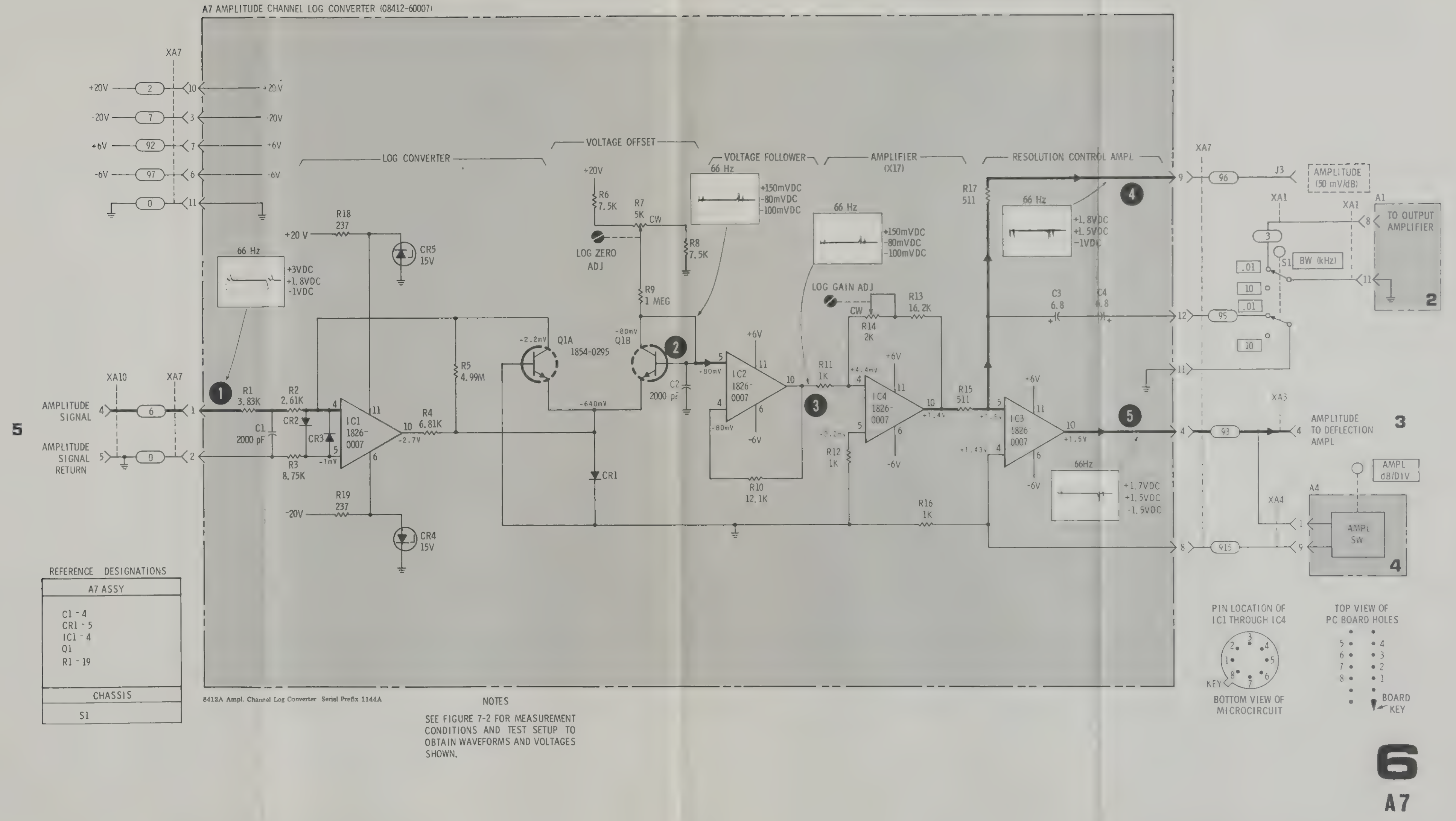


Figure 7-17. Parts Location for Amplitude Channel Log Converter A7



8412A Ampl. Channel Log Converter Serial Prefix 1144A

NOTES

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

Figure 7-18. Amplitude Channel Log Converter A7, Schematic Diagram

7 THEORY FOR TEST CHANNEL AMPLIFIER A9

26 dB (X20) AMPLIFIER

Transistors Q1-Q3 form a differential amplifier and emitter follower circuit, providing 26 dB of preamplification to the test channel signal.

2 MHz LOW PASS FILTER

The output of IC1 passes through a low pass filter which only passes signals below 2 MHz, then applies the signals to IC2.

34 dB (X50) AMPLIFIERS

Both IC1 and IC2 amplify the 278 kHz signal by 34 dB, limiting the output when the signal level is high enough in amplitude.

278 kHz BAND PASS FILTER

The output signal from IC2 passes through a 278 kHz band pass filter with a bandwidth of 10 kHz. This retains a constant-amplitude fundamental frequency, so that further limiting will produce a square wave with constant symmetry.

SQUARE WAVE GENERATOR

The output from the 278 kHz band pass filter is amplified and limited by IC3. The square wave output is applied to the phase detector and to the amplitude synchronous detector.

GROUND PLANE

The inputs of IC1, IC2, and IC3 are biased by Zener diode CR1.

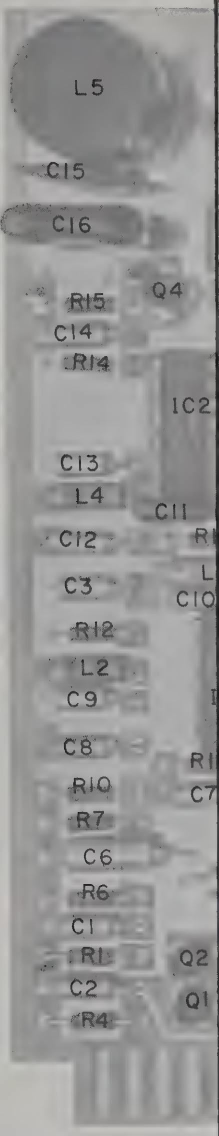
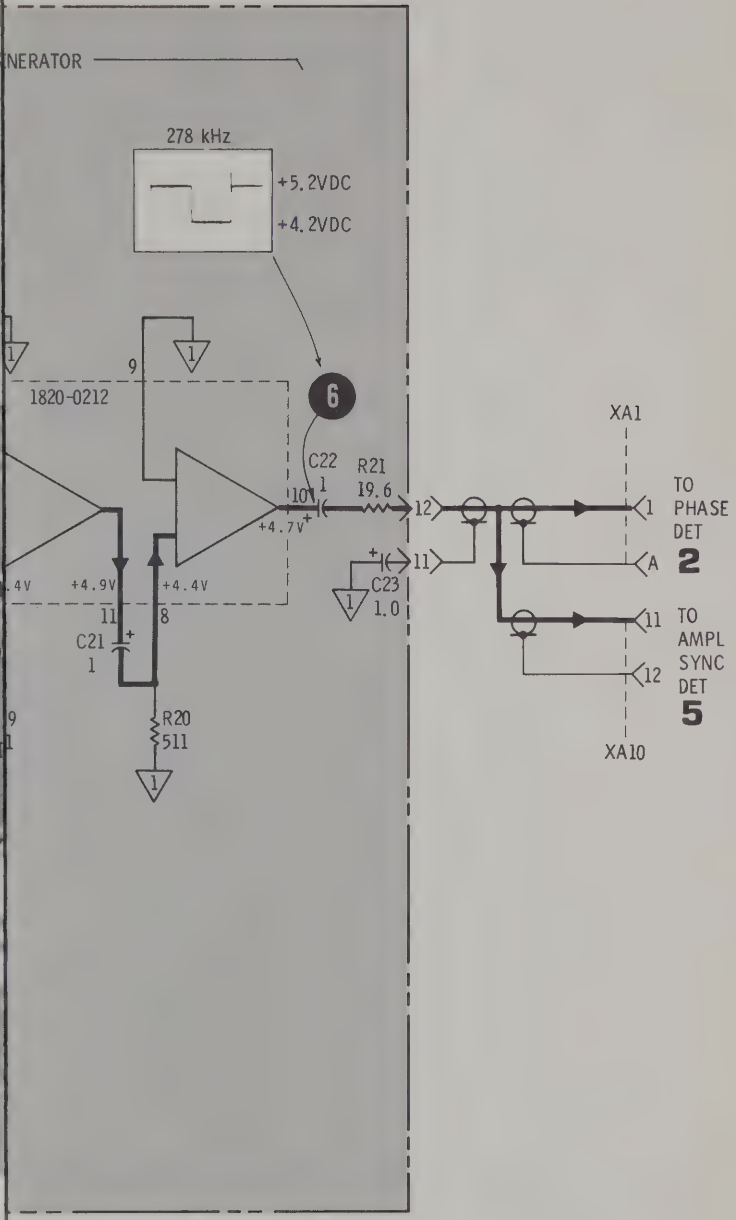


Figure 7-19. Parts Locat



7

A9

Figure 7-20. Test Channel Amplifier A9, Schematic Diagram

7 THEORY FOR TEST CHANNEL AMPLIFIER A9

26 dB (X20) AMPLIFIER

Transistors Q1-Q3 form a differential amplifier and emitter follower circuit, providing 26 dB of preamplification to the test channel signal.

2 MHz LOW PASS FILTER

The output of IC1 passes through a low pass filter which only passes signals below 2 MHz, then applies the signals to IC2.

34 dB (X50) AMPLIFIERS

Both IC1 and IC2 amplify the 278 kHz signal by 34 dB, limiting the output when the signal level is high enough in amplitude.

278 kHz BAND PASS FILTER

The output signal from IC2 passes through a 278 kHz band pass filter with a bandwidth of 10 kHz. This retains a constant-amplitude fundamental frequency, so that further limiting will produce a square wave with constant symmetry.

SQUARE WAVE GENERATOR

The output from the 278 kHz band pass filter is amplified and limited by IC3. The square wave output is applied to the phase detector and to the amplitude synchronous detector.

GROUND PLANE

The inputs of IC1, IC2, and IC3 are biased by Zener diode CR1.

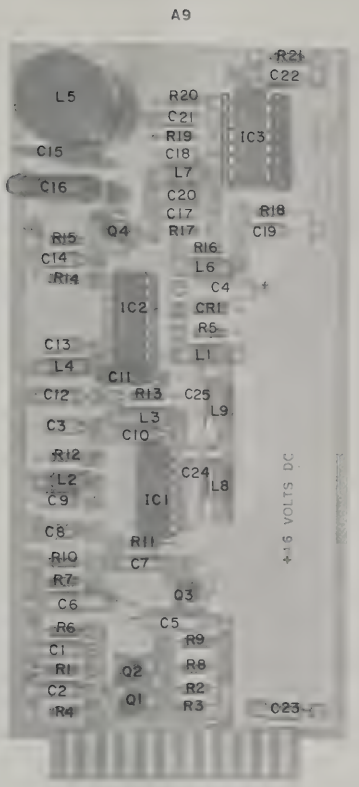
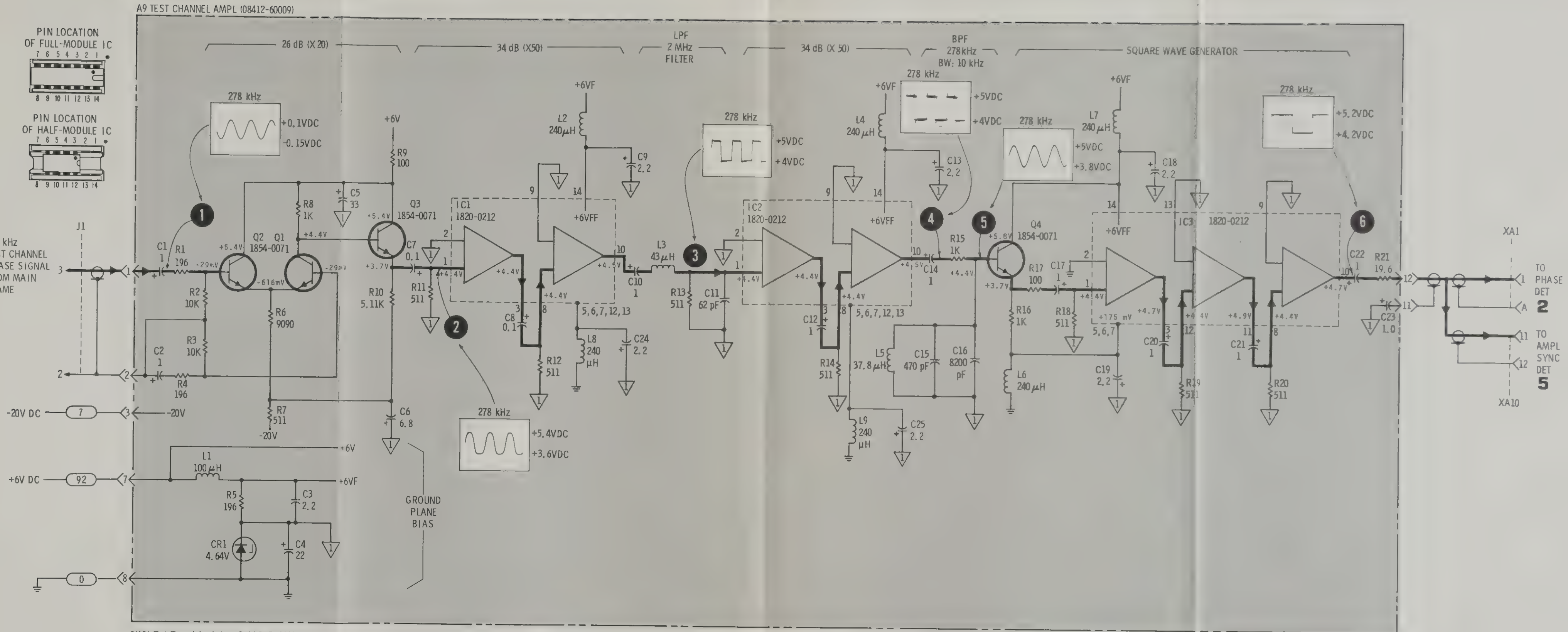


Figure 7-19. Parts Location for Test Channel Amplifier A9



8412A Test Channel Ampl. Assy Serial Prefix 1144A

REFERENCE DESIGNATIONS
A10
C1 - 25 CR1 IC1 - 3 L1 - 9 Q1 - 4 R1 - 21

NOTES

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

Figure 7-20. Test Channel Amplifier A9, Schematic Diagram

8 THEORY FOR HIGH-VOLTAGE POWER SUPPLY A5 AND RECTIFIER A6

HIGH-VOLTAGE OSCILLATOR

High voltage is developed by an oscillator circuit consisting of Q11 and the two primary windings of A6T1.

Fifty kHz oscillator energy is transformer coupled through A6T1 to the two high-voltage secondary windings, then rectified and filtered, producing a -2950 Vdc CRT cathode supply and a -2980 Vdc control grid supply.

REGULATOR FEEDBACK AMPLIFIER

The -2950 Vdc supply for the CRT cathode is voltage regulated. A small amount of voltage is obtained by a high resistance voltage divider across the supply output consisting of A5R1, A5R2, and A5R34. This is amplified through Q8, Q9, and Q10, then applied back to oscillator Q11 through T1 feedback winding. This feedback loop changes the bias on Q11, thus controlling the peak current flowing in transformer T1. This, in turn, controls the peak-to-peak voltage at the secondary of A6T1 and thus controls the high voltage output.

CRT PROTECTION

V1, R35, and CR10 form a protective circuit for the CRT. This circuit prevents the CRT grid from going positive relative to the cathode and from going farther than 120V negative from the cathode since these voltages might cause arcing between elements and damage to the CRT.

Z-AXIS BLANKING AND INTENSITY MODULATOR

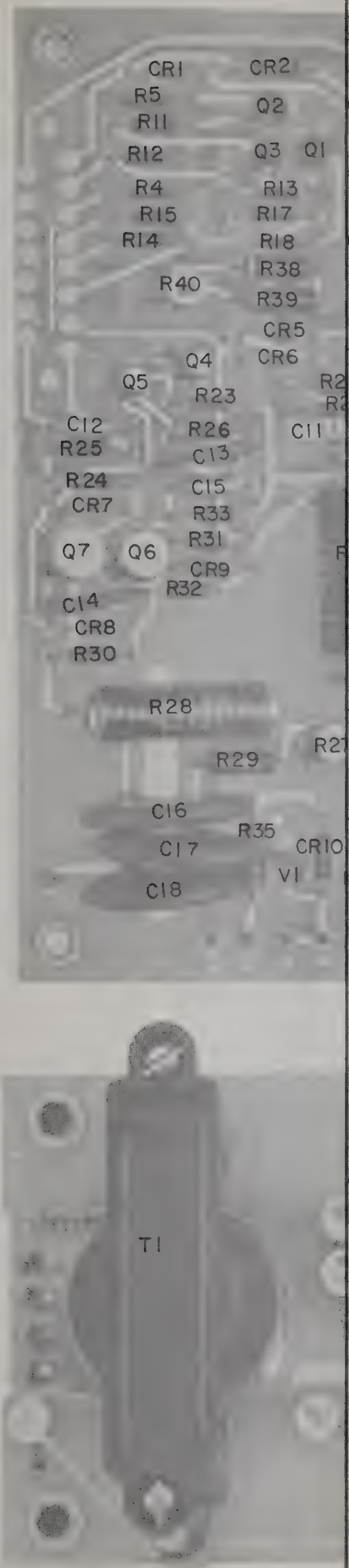
The ground return circuit for the -2980V supply driving the CRT grid is used to modulate the Z-Axis. This provides means to insert CRT blanking from several sources, and intensity modulation for frequency marking on the CRT trace. The Z-Axis modulation amplifier is composed of Q4-Q7.

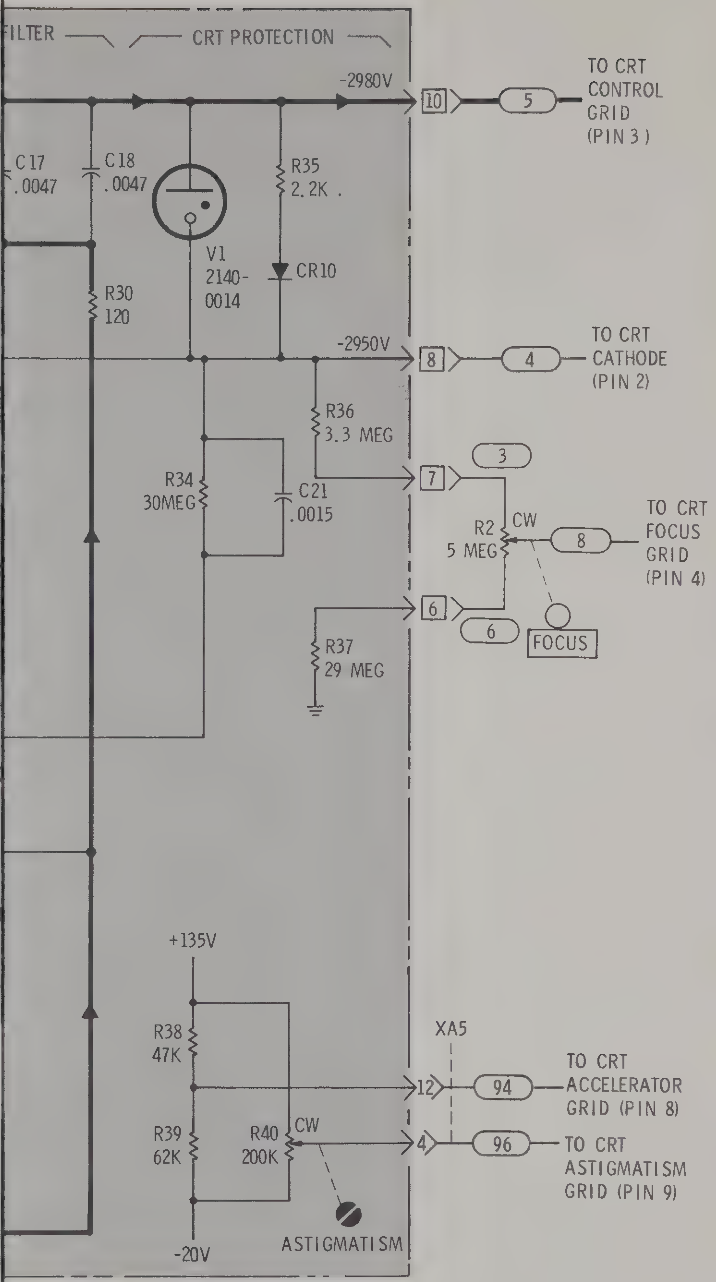
BLANKING PREAMPLIFIERS

A resistance summing network and two preamplifier stages composed of Q1-Q3, plus the intensity control circuit provide input for four different sources of Z-Axis modulation.

ASTIGMATISM

R40 adjusts astigmatism.





NOTES

ISK (*) INDICATES, FACTORY SELECTED VALUE

FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND
T SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

8

A5, A6

Figure 7-21. Parts Location for Hig

Figure 7-22. High-Voltage Power Supply A5, and Rectifier A6, Schematic Diagram

8 THEORY FOR HIGH-VOLTAGE POWER SUPPLY A5 AND RECTIFIER A6

HIGH-VOLTAGE OSCILLATOR

High voltage is developed by an oscillator circuit consisting of Q11 and the two primary windings of A6T1.

Fifty kHz oscillator energy is transformer coupled through A6T1 to the two high-voltage secondary windings, then rectified and filtered, producing a -2950 Vdc CRT cathode supply and a -2980 Vdc control grid supply.

REGULATOR FEEDBACK AMPLIFIER

The -2950 Vdc supply for the CRT cathode is voltage regulated. A small amount of voltage is obtained by a high resistance voltage divider across the supply output consisting of A5R1, A5R2, and A5R34. This is amplified through Q8, Q9, and Q10, then applied back to oscillator Q11 through T1 feedback winding. This feedback loop changes the bias on Q11, thus controlling the peak current flowing in transformer T1. This, in turn, controls the peak-to-peak voltage at the secondary of A6T1 and thus controls the high voltage output.

CRT PROTECTION

V1, R35, and CR10 form a protective circuit for the CRT. This circuit prevents the CRT grid from going positive relative to the cathode and from going farther than 120V negative from the cathode since these voltages might cause arcing between elements and damage to the CRT.

Z-AXIS BLANKING AND INTENSITY MODULATOR

The ground return circuit for the -2980V supply driving the CRT grid is used to modulate the Z-Axis. This provides means to insert CRT blanking from several sources, and intensity modulation for frequency marking on the CRT trace. The Z-Axis modulation amplifier is composed of Q4-Q7.

BLANKING PREAMPLIFIERS

A resistance summing network and two preamplifier stages composed of Q1-Q3, plus the intensity control circuit provide input for four different sources of Z-Axis modulation.

ASTIGMATISM

R40 adjusts astigmatism.

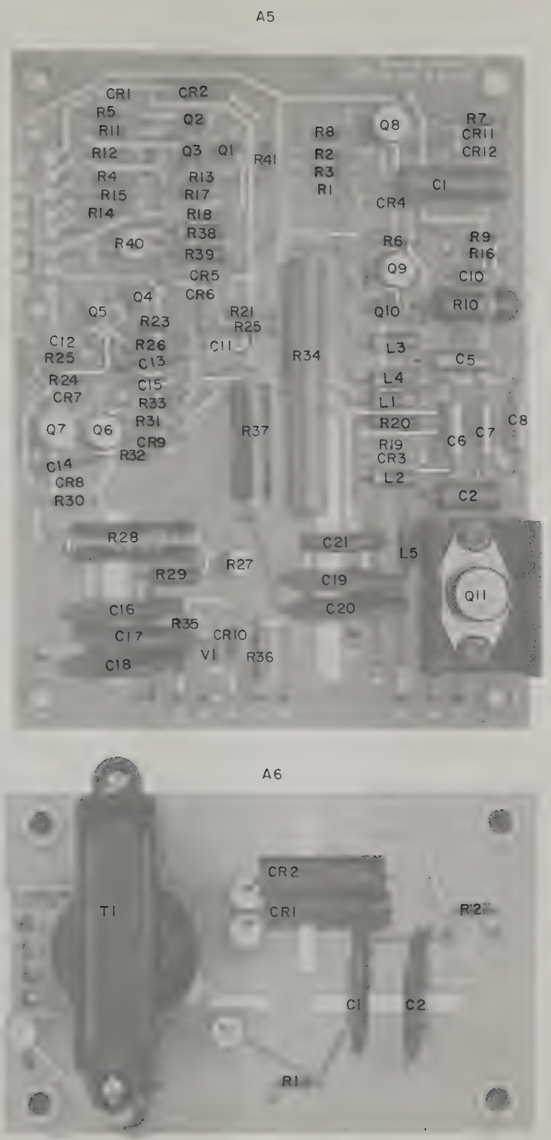
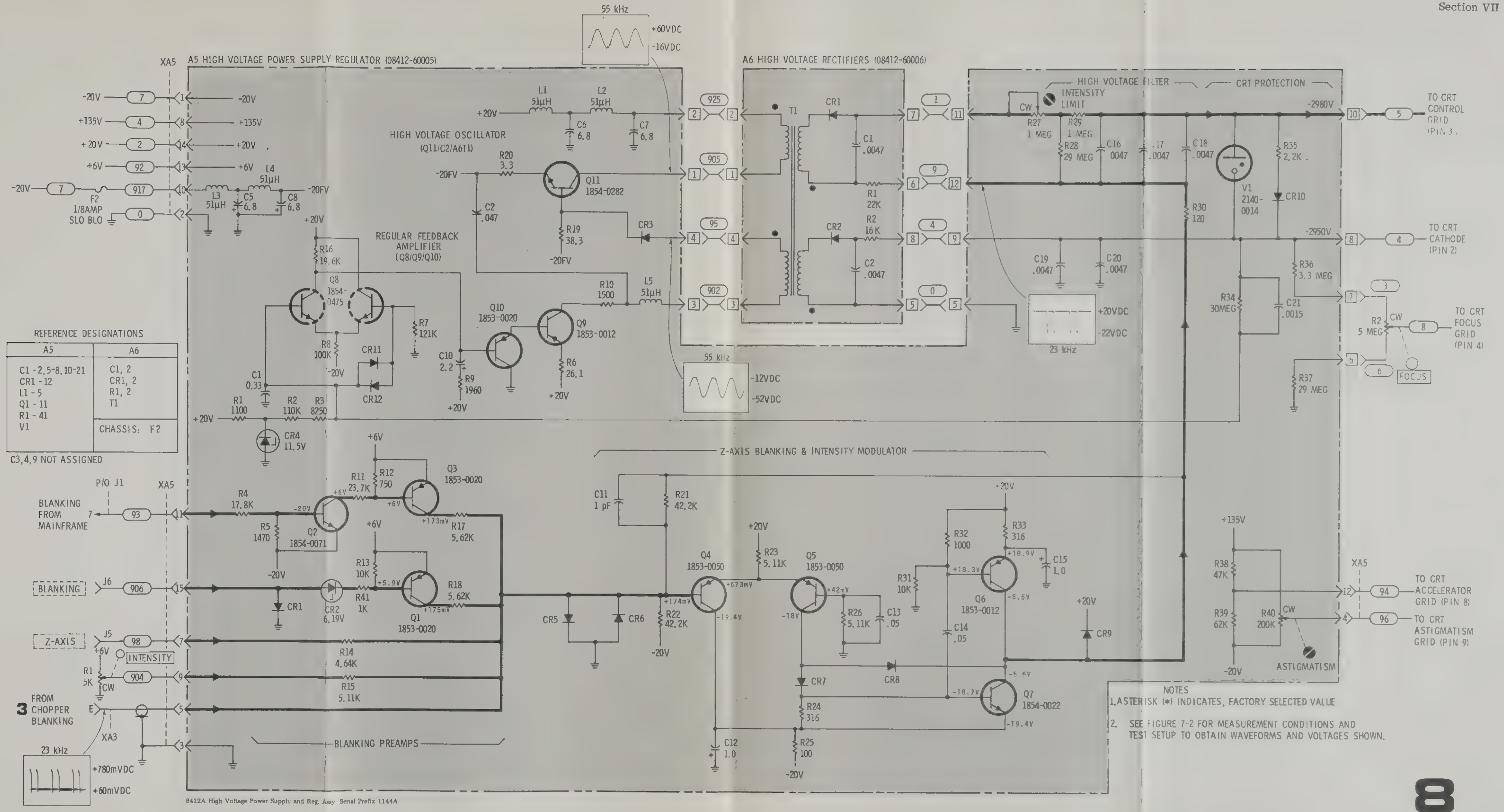


Figure 7-21. Parts Location for High-Voltage Power Supply A5, and Rectifier A6



REFERENCE DESIGNATIONS

A5	A6
C1 -2,5-8,10-21 CR1 - 12 L1 - 5 Q1 - 11 R1 - 41 V1	C1, 2 CR1, 2 R1, 2 T1
	CHASSIS: F2

C3,4,9 NOT ASSIGNED

NOTES
1. ASTERISK (*) INDICATES, FACTORY SELECTED VALUE
2. SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

8
A5, A6

Figure 7-22. High-Voltage Power Supply A5, and Rectifier A6, Schematic Diagram

9 THEORY FOR LOW VOLTAGE POWER SUPPLY A8

±6 VOLT SUPPLY

Series regulator Q3 is driven by IC1, maintaining a regulated 12 Volts across the +6 Volt and -6 Volt supplies (between pins 1 and 6). The 12 Volts is adjusted by R4. Resistors R2, R3, and R4 sense any change from 12 Volts, amplifying the change through IC1, then changing the bias on Q3 to bring the output back to 12 Volts. Resistors R5 and R6 form a voltage divider across the 12 Volt output, dropping 6 Volts across each resistor. The voltage at the center of the voltage divider is compared to ground at the input of IC2. The resultant output from IC2 drives Q1 and Q2. Q1 and Q2 together with their associated resistors R9 and R10 balance the load impedance across the plus and minus 6 Volts to maintain 6 Volts across each supply. This compensates for the difference in load presented by the instrument circuits to the two supplies. This means that the total current drawn by Q1 and the -6 Volt load circuits will equal the total current drawn by Q2 and the +6 Volt load circuits.

+135 VOLT SUPPLY

Capacitor C4 together with rectifier diodes CR3 and CR4 and transformer T1 make the unregulated 135 Volt supply.

TRACE ALIGN

R8 adjusts trace align on CRT.

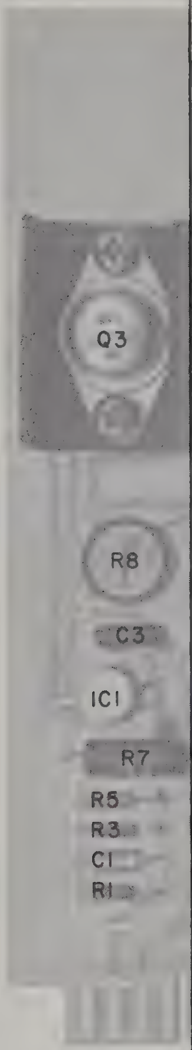
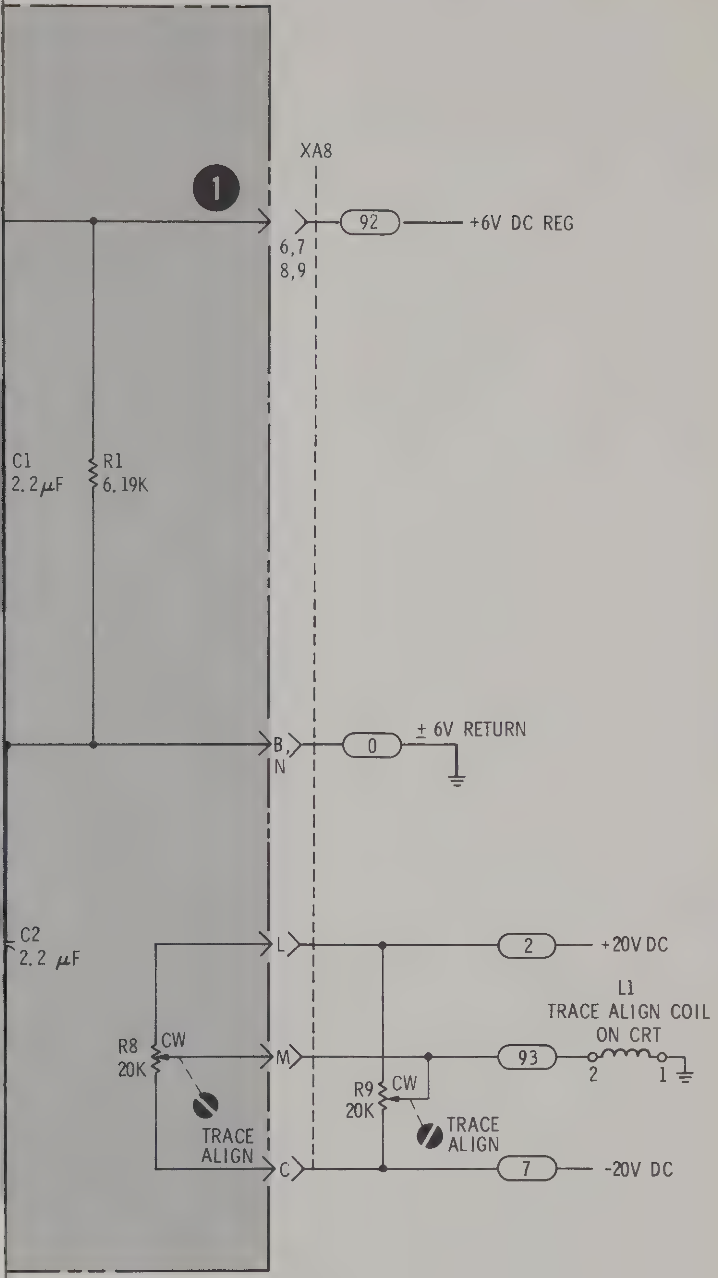


Figure 7-23. Part
Pow



9

A8

Figure 7-24. Low-Voltage Power Supply A8,
Schematic Diagram

9 THEORY FOR LOW VOLTAGE POWER SUPPLY A8

±6 VOLT SUPPLY

Series regulator Q3 is driven by IC1, maintaining a regulated 12 Volts across the +6 Volt and -6 Volt supplies (between pins 1 and 6). The 12 Volts is adjusted by R4. Resistors R2, R3, and R4 sense any change from 12 Volts, amplifying the change through IC1, then changing the bias on Q3 to bring the output back to 12 Volts. Resistors R5 and R6 form a voltage divider across the 12 Volt output, dropping 6 Volts across each resistor. The voltage at the center of the voltage divider is compared to ground at the input of IC2. The resultant output from IC2 drives Q1 and Q2. Q1 and Q2 together with their associated resistors R9 and R10 balance the load impedance across the plus and minus 6 Volts to maintain 6 Volts across each supply. This compensates for the difference in load presented by the instrument circuits to the two supplies. This means that the total current drawn by Q1 and the -6 Volt load circuits will equal the total current drawn by Q2 and the +6 Volt load circuits.

+135 VOLT SUPPLY

Capacitor C4 together with rectifier diodes CR3 and CR4 and transformer T1 make the unregulated 135 Volt supply.

TRACE ALIGN

R8 adjusts trace align on CRT.

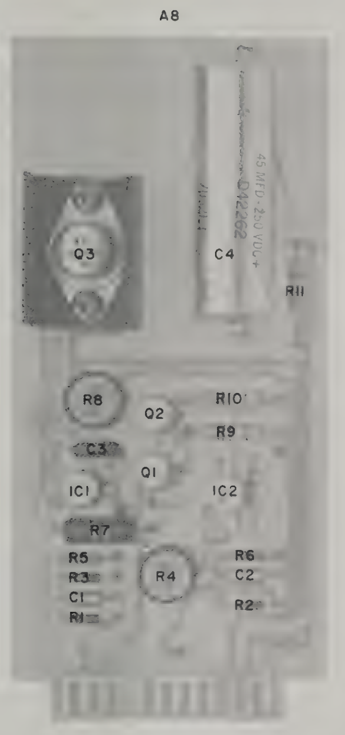
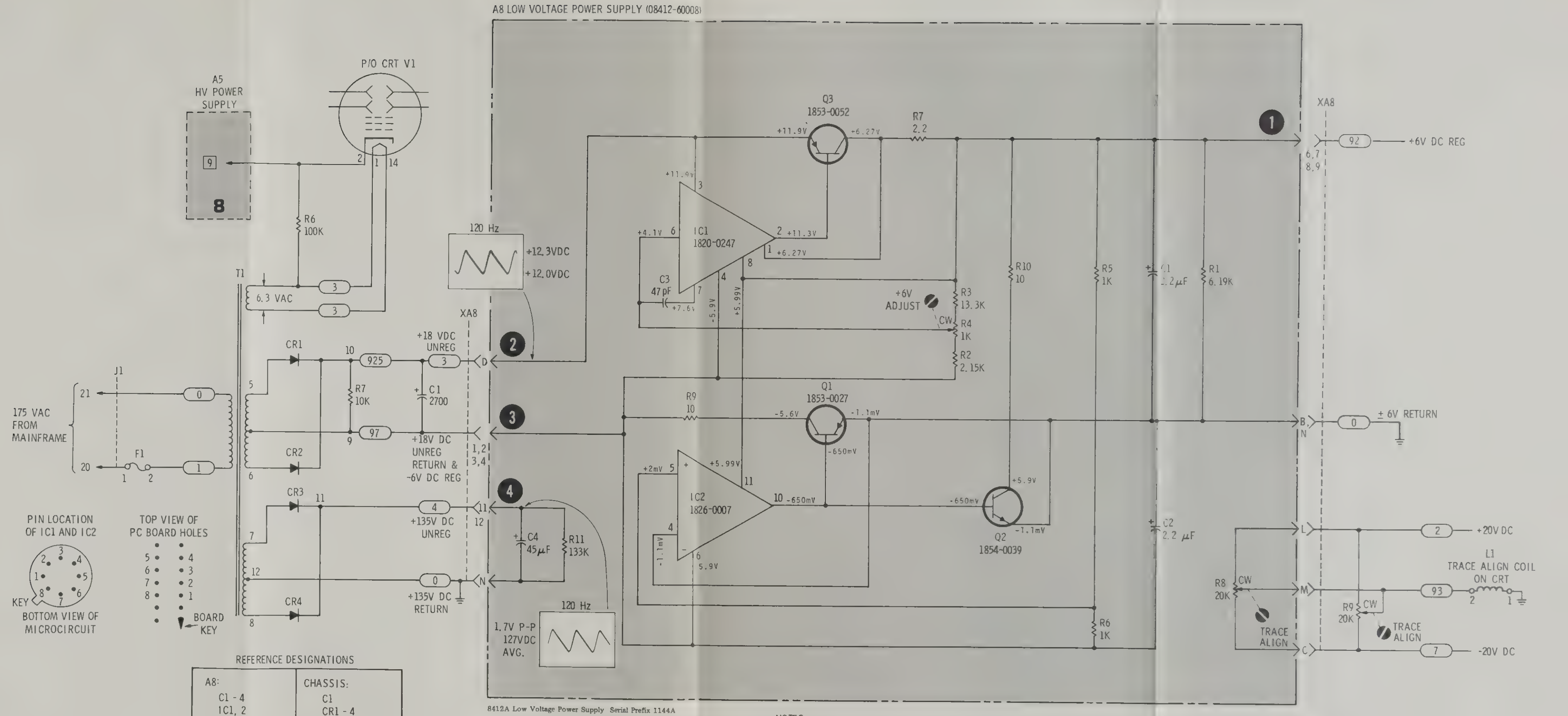


Figure 7-23. Parts Location for Low-Voltage Power Supply A8



REFERENCE DESIGNATIONS

A8:	CHASSIS:
C1 - 4 IC1, 2 Q1 - 3 R1 - 11	C1 CR1 - 4 F1 J1 L1 R6, 7, 9 T1 V1

NOTES
SEE FIGURE 7-2 FOR
MEASUREMENT CONDITIONS
AND TEST SETUP TO OBTAIN
WAVEFORMS AND VOLTAGES
SHOWN

9
A8

Figure 7-24. Low-Voltage Power Supply A8, Schematic Diagram

APPENDIX I

MANUAL CHANGES

I-1. INTRODUCTION

I-2. To adapt this manual to instruments with serial numbers prefixed 929, 945, 957, 968, 970, and 976 make the changes indicated below.

929-00129 and below	A-I
929-011-929-00130	A-H
945-00131-945-00157	A-G
945-00158-945-00195	A-F
945-00196-957-00245	A-E

968-00246-968-00295	A, B, C, D
970-00296-970-00395	A, B, C
976-00396-976-00445	A, B
976-00446-976-00529	A

CHANGE A

Instruments with serial numbers 976-00529 and below may not have resistor A7R5. The performance of the 8412A may be improved by adding a 4.99 megohm resistor (HP Part No. 0698-4348) on A7 (08412-60007). See Figures 7-17 and 7-18 on page 7-17 of Manual for proper location of A7R5.

CHANGE B

Instruments with serial numbers 976-00445 and below may have dual inline flat pack IC (HP Part No. 1820-0123) for A8IC1. The TO-99 type package (HP Part No. 1820-0247) is the recommended replacement. The TO-99 offers greater reliability than the flat pack. See schematic diagram on page 7-23 for pin location of TO-99.

CHANGE C

Instruments with serial numbers 970-00395 and below may have dual in-line flat pack IC's (HP Part No. 1820-0216) for the following operational amplifiers:

A1IC2
A7IC1, 2, 3, and 4
A8IC2
A10IC1

The recommended replacement for the flat pack IC's forementioned is the TO-99 type package HP Part No. 1826-0007.

CHANGE D

Page 6-7, Table 6-1:

Change A9C4 to HP Part No. 0180-0197 C:FXD
ELECT 2.2 UF 10% 20 VDCW

Page 7-19, Figure 7-19:

Delete C24 and C25
Delete L8 and L9

Page 7-19, Figure 7-20:

Change the value of A9C4 to 2.2 μF
Delete A9L8 and A9C24. Ground pins 5, 6, 7, 12, 13 of IC1.
Delete A9L9 and A9C25. Ground pins 5, 6, 7, 12, 13 of IC2.

CHANGE E

Page 6-5, Table 6-1:

Change A5C1 to HP Part No. 0160-0168; C: FXD MY 0.1 UF 10% 200 VDCW.
Change A5C2 to HP Part No. 0180-0116; C: FXD ELECT 6.8 UF 10% 35 VDCW.
Add A5C3, HP Part No. 0180-0116; C: FXD ELECT 6.8 UF 10% 35 VDCW.
Add A5C9, HP Part No. 0160-2917; C: FXD CER 0.05 UF +80 -20% 100 VDCW.
Change A5C10 to HP Part No. 0160-0168; C: FXD MY 0.1 UF 10% 200 VDCW.
Change A5C13 and A5C14 to HP Part No. 0160-2917; C: FXD CER 0.05 UF +80 -20% 100 VDCW.
Change A5CR3 to Part No. 1901-0049; DIODE: SILICON 50 PIV.
Change A5CR4 to HP Part No. 1901-0040; DIODE: SILICON 30 MA 30 WV.

Page 6-6, Table 6-1:

Change A5L1, A5L2, A5L3, and A5L4 to Part No. 9100-1625; COIL/CHOKE 33 μH.
Change A5Q8 to HP Part No. 1855-0062; Q: FET.
Change A5Q9 to HP Part No. 1853-0050; Q: SI PNP.
Change A5Q10 to HP Part No. 1854-0022; Q: SI NPN (SELECTED FROM 2N3102).
Change A5R1 to HP Part No. 0757-0154; R: FXD MET FLM 278K OHM 1% 1/2W.
Change A5R2 to HP Part No. 0757-0123; R: FXD MET FLM 34.8K OHM 1% 1/8W.
Change A5R3 to HP Part No. 0757-0447; R: FXD MET FLM 16.2K OHM 1% 1/8W.
Change A5R6 to HP Part No. 0757-0467; R: FXD MET FLM 121 OHM 1% 1/8W.
Change A5R7 to HP Part No. 0757-0317; R: FXD MET FLM 1.33K OHM 1% 1/8W.
Change A5R8 to HP Part No. 0698-0085; R: FXD MET FLM 2.61K OHM 1% 1/8W.
Change A5R9 to HP Part No. 0968-3159; R: FXD MET FLM 26.1K OHM 1% 1/8W.
Change A5R10 to HP Part No. 0757-0289; R: FXD MET FLM 13.3K OHM 1% 1/8W.
Change A5R16 to HP Part No. 0698-0083; R: FXD MET FLM 1.96K OHM 1% 1/8W.
Change A5R19 to HP Part No. 0698-3442; R: FXD MET FLM 237 OHM 1% 1/8W.
Change A5R20 to HP Part No. 0757-0159; R: FXD MET FLM 1000 OHM 1% 1/2W.
Change A5R22 to HP Part No. 0698-3161; R: FXD MET FLM 38, 3K 1% 1/8W.
Change A5R32 to HP Part No. 0757-0159; R: FXD MET FLM 1000 OHM 1% 1/2W.
Recommended replacement is 0757-0280; R: FXD 1000 OHMS.

Page 7-21, Figures 7-21 and 7-22:

Replace Figure 7-21 in Manual with Figure 7-21 (change E) in this appendix.
Replace Figure 7-22 in Manual with Figure 7-22 (change E) in this appendix.

CHANGE F

Page 6-4, Table 6-1:

Change A3 R24 and A3R25 to HP Part No. 2100-2489; R: VAR FLM 5K OHM 10% LIN 1/2W.

Page 6-7, Table 6-1:

Change A7C3 and A7C4 to HP Part No. 0180-2141; C: FXD ELECT 3.3 UF 10% 50 VDCW.
Change A7R1 to HP Part No. 0698-3154; R: FXD MET FLM 4.22K OHM 1% 1/8W.
Change A7R2 to HP Part No. 0698-3153; R: FXD MET FLM 3.83K 1% 1/8W.
Change A7R3 and A7R4 to HP Part No. 0757-0442; MET FLM 10.0K 1% 1/8W.
Change A7R5 to HP Part No. 0698-5094; R: FXD COMP 5.1 MEGOHM 5% 1/8W.
Change A7R15 to HP Part No. 0757-0280; R: FXD MET FLM 1K OHM 1% 1/8W.

Page 6-9, Table 6-1:

Change A10C1 and A10C2 to HP Part No. 0160-0161; C: FXD MY 0.01 UF 10% 200 VDCW.
Add A10L1 and A10L2.
Change A10R4 to HP Part No. 0698-3444; R: FXD MET FLM 316 OHM 1% 1/8W.
Change A10R5 to HP Part No. 0698-0083; R: FXD MET FLM 1.96K OHM 1% 1/8W.
Change A10R7 to HP Part No. 0757-0438; R: FXD MET FLM 5.11K OHM 1% 1/8W.
Change A10R8 to HP Part No. 0698-3444; R: FXD MET FLM 316 OHM 1% 1/8W.
Change A10R14 to HP Part No. 0698-3440; R: FXD MET FLM 196 OHM 1% 1/8W.
Change A10R15 and A10R16 to HP Part No. 0698-3159; R: FXD MET FLM 26.1K OHM 1% 1/8W.
Change A10R17 and A10R21 to HP Part No. 0698-3153; R: FXD MET FLM 3.83K 1% 1/8W.

CHANGE F (CONTINUED)

Page 6-9, Table 6-1:

Change A10R18, A10R20, A10R27 and A10R36 to HP Part No. 0698-5438 R: FXD FLM 100 OHM 0.25% 1/8W.
Change A10R19 to HP Part No. 0757-0416; R: FXD MET FLM 511 OHM 1% 1/8W.
Change A10R22 to HP Part No. 0698-3155; R: FXD MET FLM 4.64 1% 1/8W.
Change A10R23 to HP Part No. 0698-3156; R: FXD MET FLM 14.7K OHM 1% 1/8W.

Page 6-10, Table 6-1:

Change A10R39 to HP Part No. 0698-3136; R: FXD MET FLM 17.8K OHM 1% 1/8W.

Page 7-11, Figure 7-11 and 7-12:

Replace Figure 7-11 in Manual with Figure 7-11 (Change F) in this appendix.
Replace Figure 7-12 in Manual with Figure 7-12 (Change F) in this appendix.

Page 7-15, Figures 7-15 and 7-16:

Replace Figure 7-15 in Manual with Figure 7-15 (Change F) in this appendix.
Replace Figure 7-16 in Manual with Figure 7-16 (Change F) in this appendix.

Page 7-17, Figures 7-17 and 7-18:

Replace Figure 7-17 in Manual with Figure 7-17 (Change F) in this appendix.
Replace Figure 7-18 in Manual with Figure 7-18 (Change F) in this appendix.

Page 7-23, Figure 7-24:

Delete R9 TRACE ALIGN control, Figure 7-24 of Manual.

CHANGE G

Page 7-21, Figure 7-22:

Delete A5C11 and A5C12 in Figure 7-22 of Manual. Show direct connections from both bases of Q8 to the junction of A5C1 and A5R3.

CHANGE H

Page 6-5, Table 6-1:

Change A5C1 to HP Part No. 0160-0168; C: FXD MY 0.1 UF 10% 200 VDCW.
Add A5C4 HP Part No. 0160-0174; C: FXD CER 0.47 UF +80 -20% 25 VDCW.
Change A5C10 to HP Part No. 0160-0165; C: FXD MY 0.056 UF 10% 200 VDCW.

Page 6-6, Table 6-1:

Change A5Q9 to HP Part No. 1853-0020; Q: SI PNP (Selected from 2N3702).
Change A5Q10 to HP Part No. 1854-0071; Q: SI NPN (Selected from 2N3704).
Change A5R2 to HP Part No. 0698-3450; R: FXD MET FLM 42.2K OHM 1% 1/8W, FACTORY SELECTED PART.
Add A5R3 HP Part No. 0757-0447; R: FXD MET FLM 16.2K OHM 1% 1/8W.

Page 7-21, Figure 7-22:

Replace Figure 7-22 in Manual with Figure 7-22 (Change H) in this appendix.

CHANGE I

Page 6-7, Table 6-1:

Change A9C8 to HP Part No. 0180-0291; C: FXD ELECT 1.0 UF 10% 35 VDCW.

Page 7-19, Figure 7-20:

Change A9C8 to 1.0 UF.

CHANGE J

Instruments with serial numbers prefixed 1144A and below may have HP Part No. 1854-0221 for A2Q12, A2Q13, A5Q8, A10Q8, and A10Q10. Recommended replacement is 1854-0475.

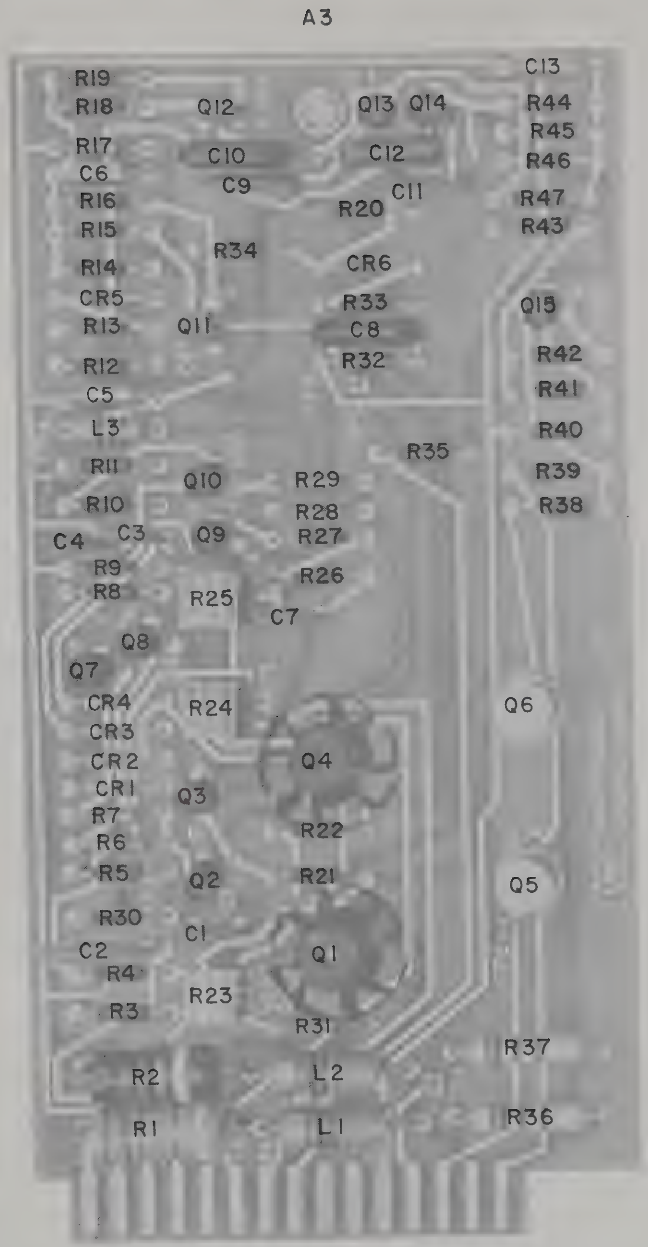


Figure 7-11. Parts Location for Multiplexer and Deflection Amplifier A3

(Change F, Serial No. 945-00195 and below)

A10

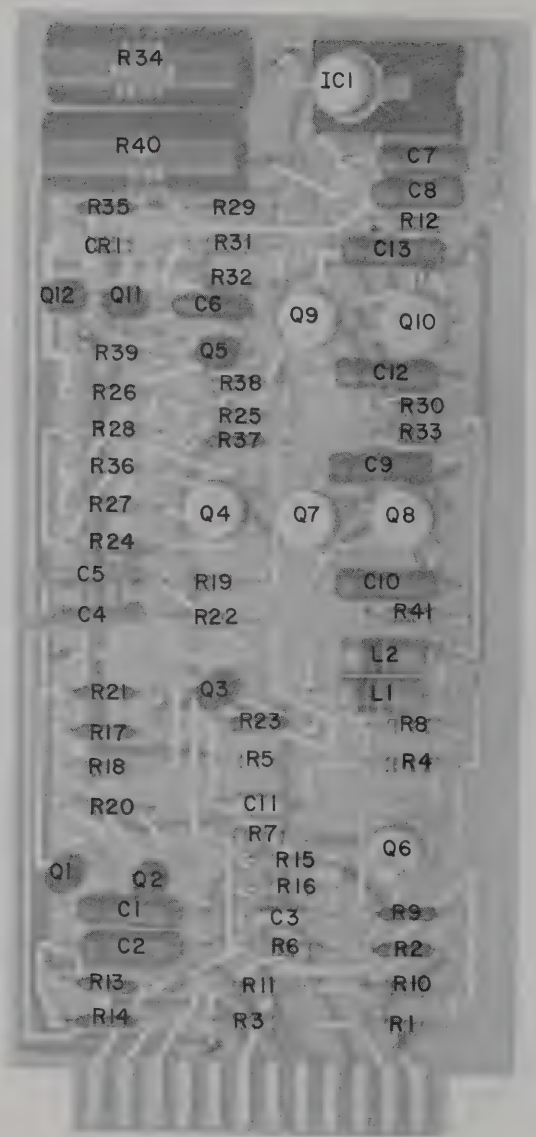


Figure 7-15. Parts Location for Amplitude Synchronous Detector A10

(Change F, Serial No. 945-00195 and below)

A7

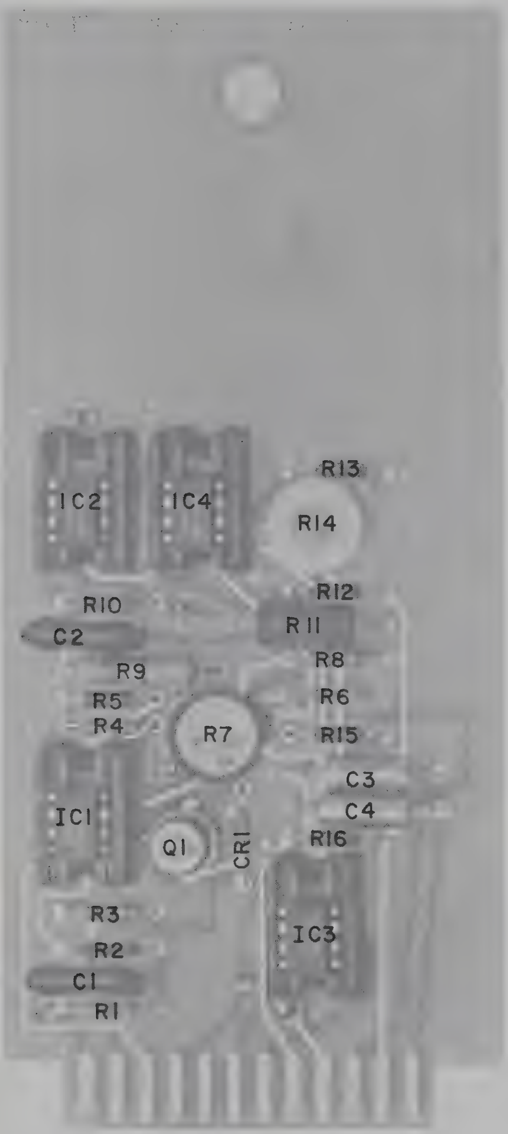
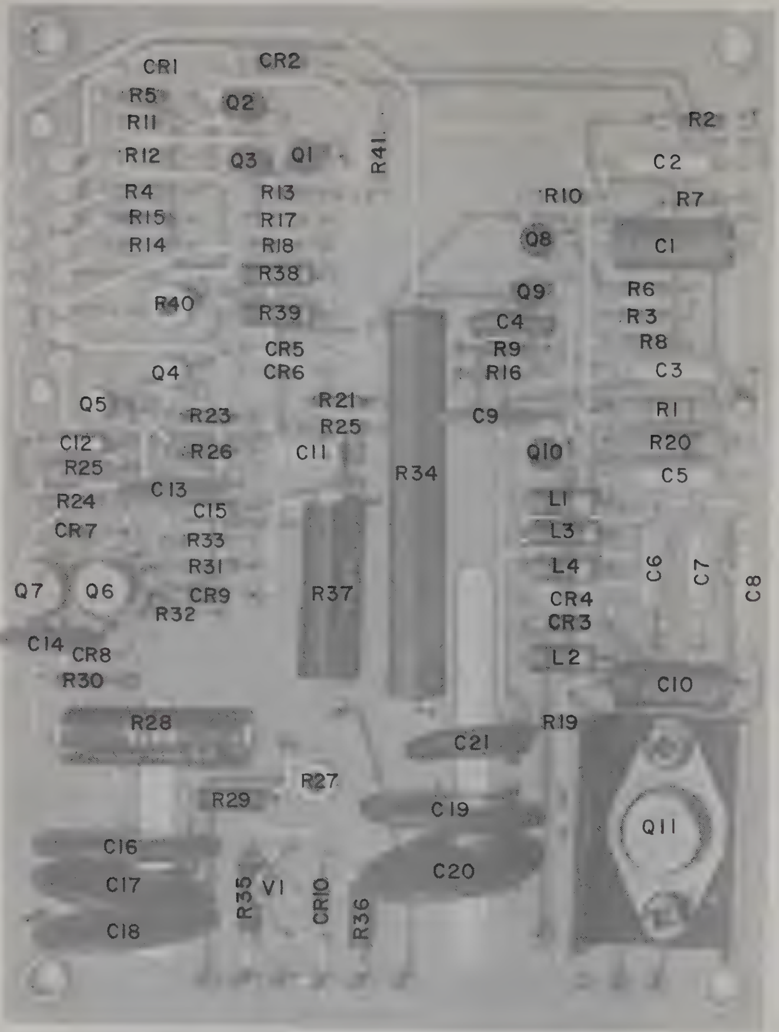


Figure 7-17. Parts Location for Amplitude Channel Log Converter A7

(Change F, Serial No. 945-00195 and below)

A5



A6

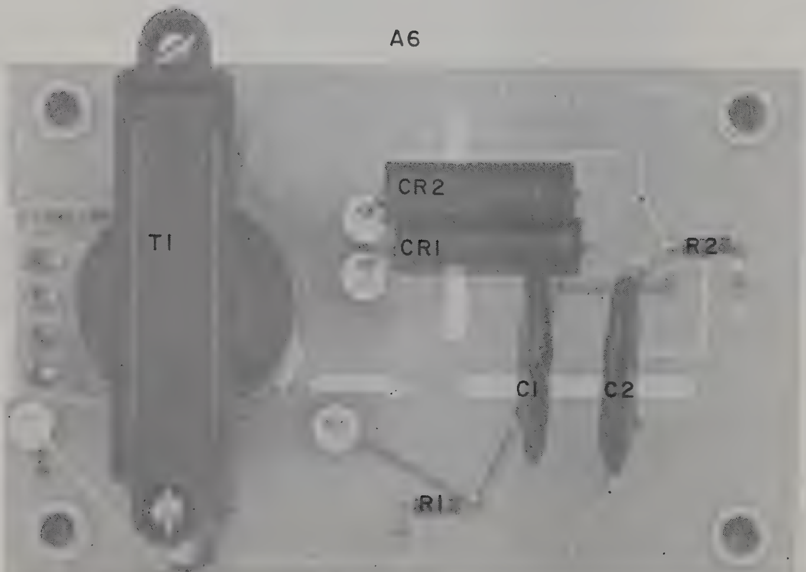


Figure 7-21. Parts Location for High-Voltage Power Supply A5, and Rectifier A6 (Change E, Serial No. 945-00131 and below)

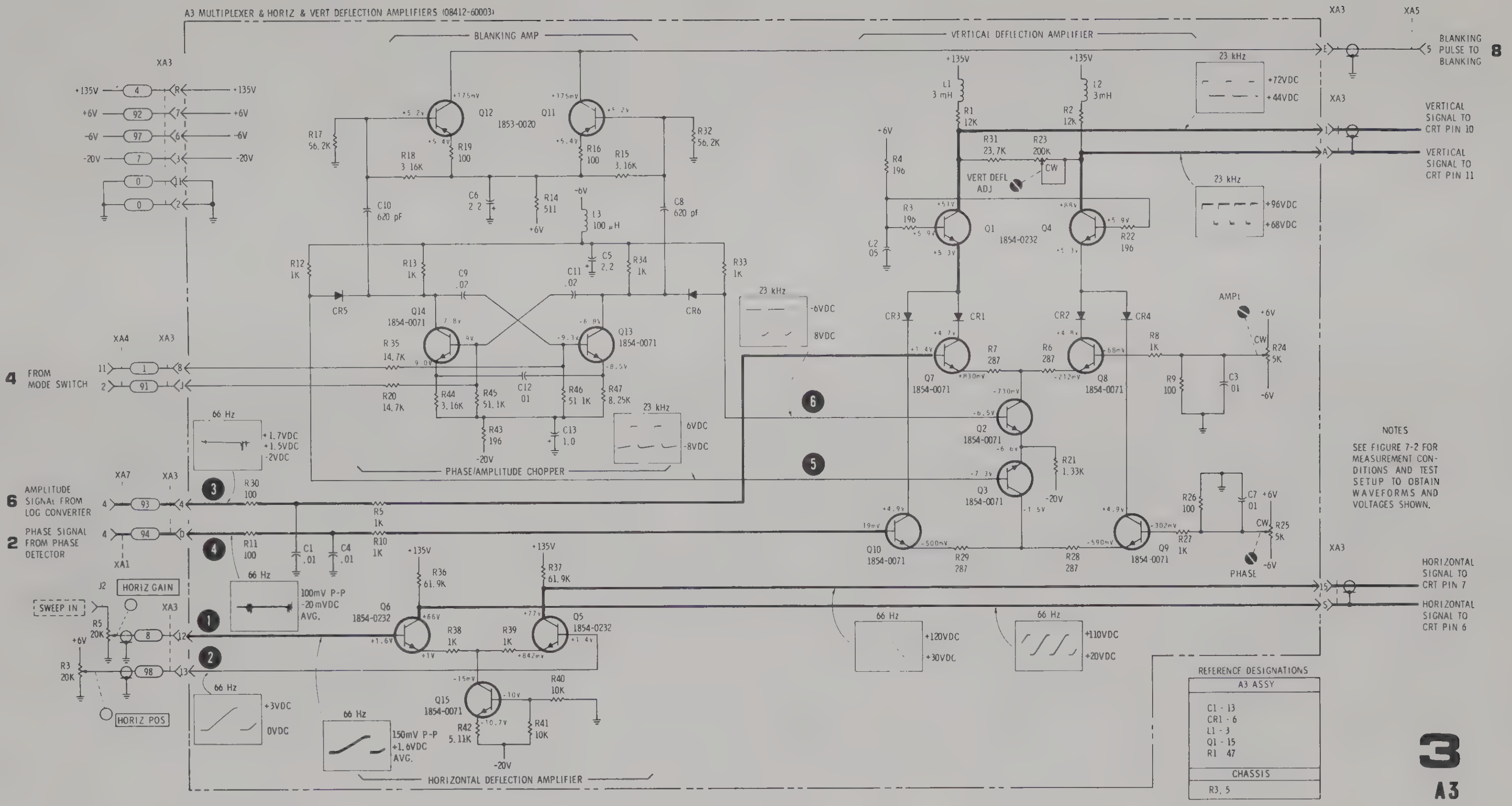
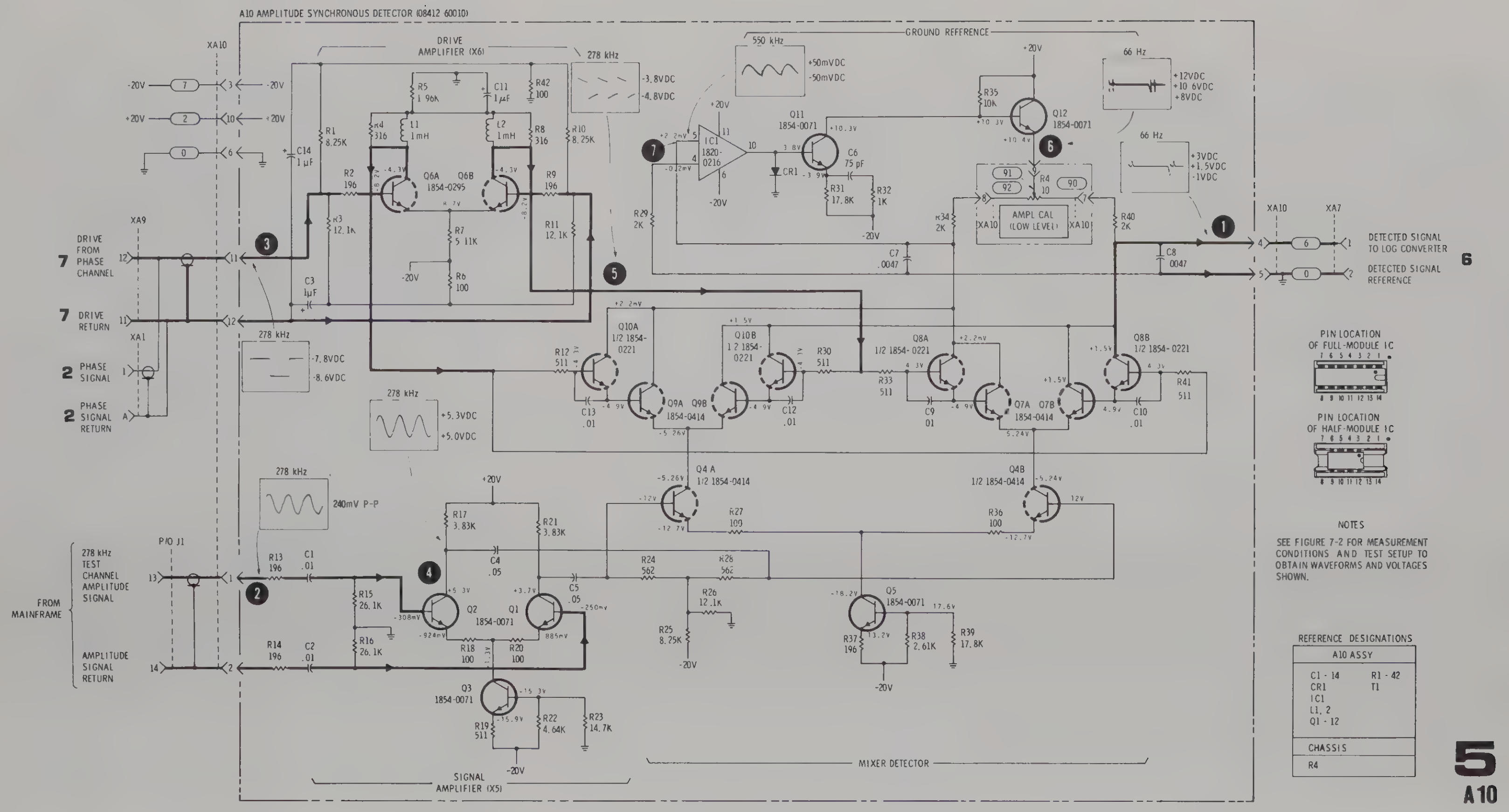

A3 MULTIPLEXER & HORIZ & VERT DEFLECTION AMPLIFIERS (08412-60003)
BLANKING AMP
VERTICAL DEFLECTION AMPLIFIER
PHASE/AMPLITUDE CHOPPER
HORIZONTAL DEFLECTION AMPLIFIER
BLANKING PULSE TO BLANKING 8
VERTICAL SIGNAL TO CRT PIN 10
VERTICAL SIGNAL TO CRT PIN 11
HORIZONTAL SIGNAL TO CRT PIN 7
HORIZONTAL SIGNAL TO CRT PIN 6
4 FROM MODE SWITCH
6 AMPLITUDE SIGNAL FROM LOG CONVERTER
2 PHASE SIGNAL FROM PHASE DETECTOR
SWEEP IN
HORIZ GAIN
HORIZ POS
VERT DEFL ADJ
AMPL
PHASE
XA3
XA4
XA5
XA7
XA1
J2
NOTES
SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.
REFERENCE DESIGNATIONS
A3 ASSY
C1 - 13
CR1 - 6
L1 - 3
Q1 - 15
R1 47
CHASSIS
R3, 5
3
A3

Figure 7-12. Multiplexer and Deflection Amplifier A3, Schematic Diagram (Change F, Serial No. 945-00195 and below)

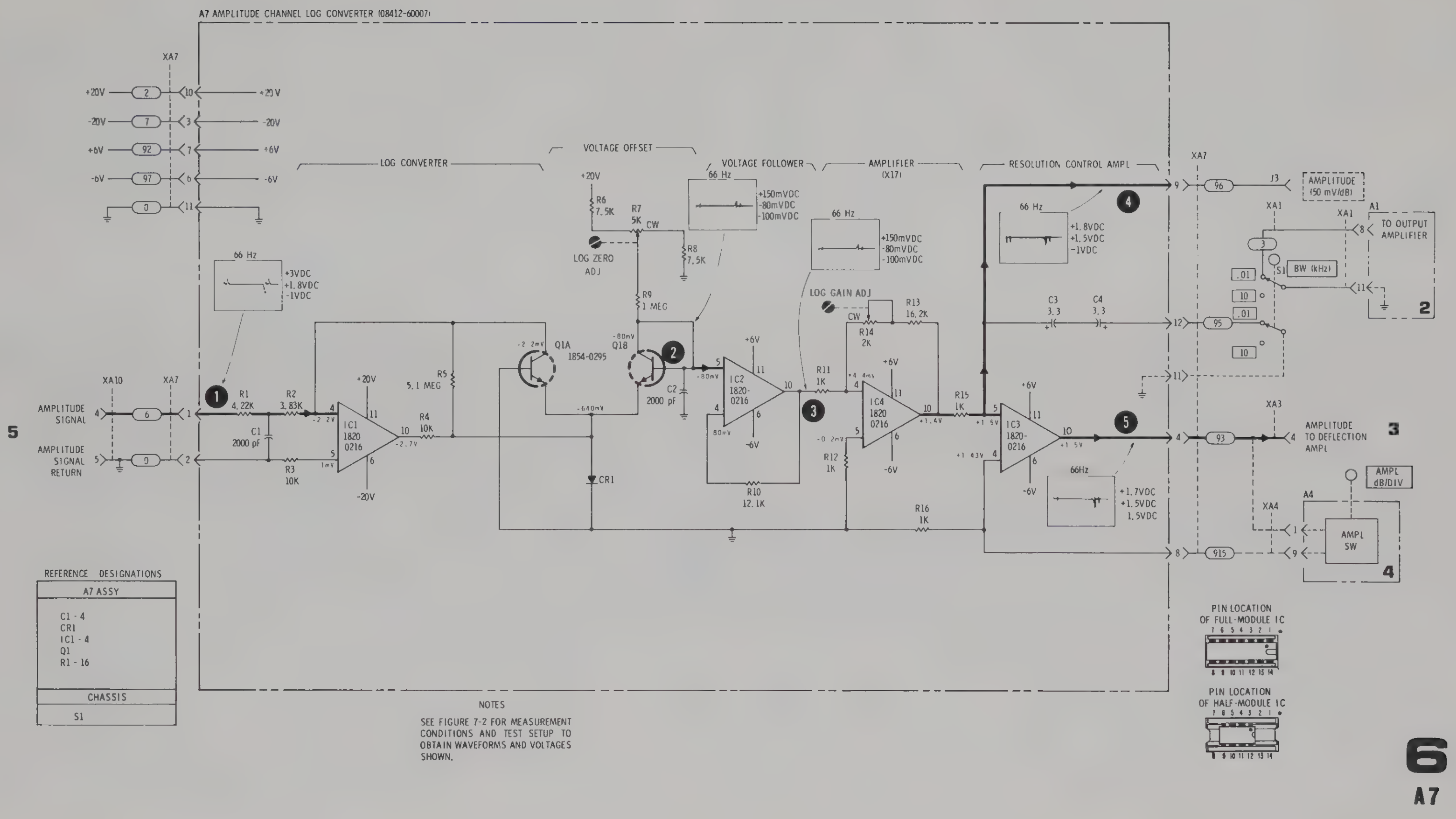


NOTES

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

REFERENCE DESIGNATIONS	
A10 ASSY	
C1 - 14 CR1 IC1 L1, 2 Q1 - 12	R1 - 42 T1
CHASSIS	
R4	

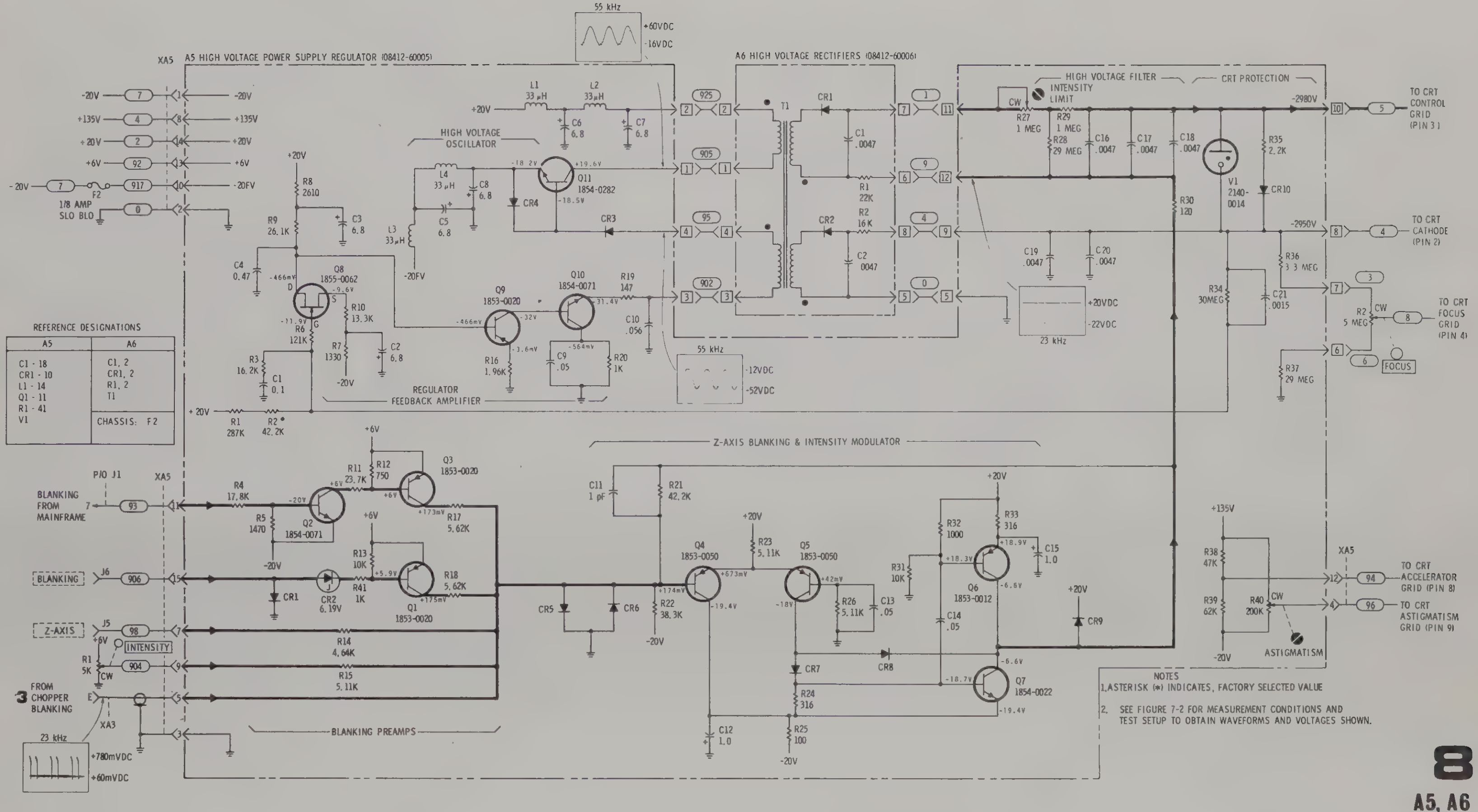
Figure 7-16 Amplitude Synchronous Detector A10, Schematic Diagram
(Change F, Serial No. 945-00195 and below)



NOTES

SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

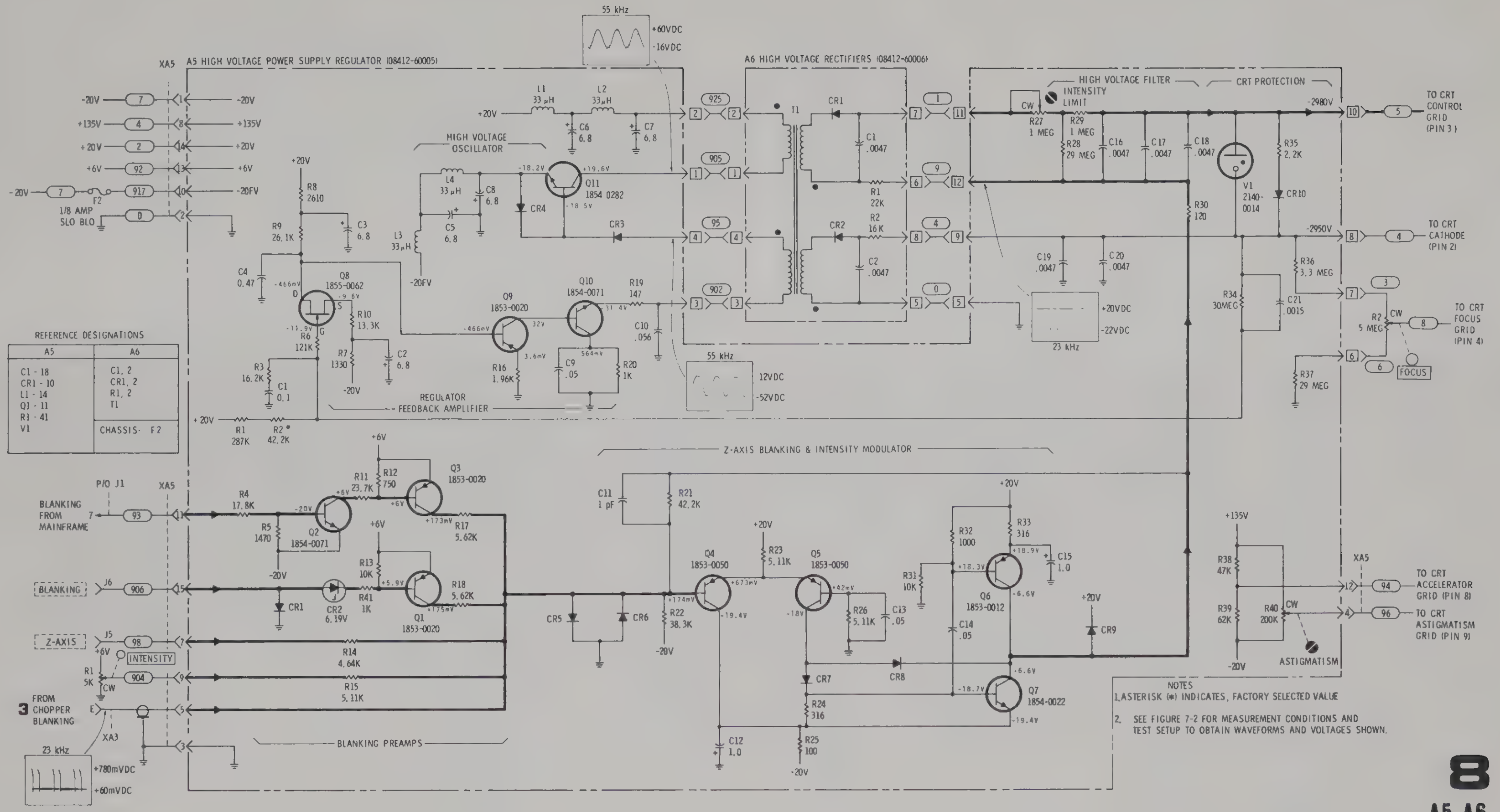
Figure 7-18. Amplitude Channel Log Converter A7, Schematic Diagram (Change F, Serial No. 945-00195 and below)



NOTES

1. ASTERISK (*) INDICATES, FACTORY SELECTED VALUE
2. SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

Figure 7-22. High-Voltage Power Supply A5, and Rectifier A6, Schematic Diagram (Change E, Serial Nos. 945-00131 through 957-00245)



REFERENCE DESIGNATIONS

A5	A6
C1 - 18 CR1 - 10 L1 - 14 Q1 - 11 R1 - 41 V1	C1, 2 CR1, 2 R1, 2 T1
	CHASSIS - F2

NOTES

1. ASTERISK (*) INDICATES, FACTORY SELECTED VALUE
2. SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

Figure 7-22. High-Voltage Power Supply A5, and Rectifier A6, Schematic Diagram (Change H, Serial No. 929-00130 and below)

APPENDIX II

OPTION HO7 MANUAL SUPPLEMENT

II-1. INTRODUCTION

II-2. This supplement describes the difference in the Model 8412A Phase-Magnitude Display with Option HO7. It also describes the manual changes necessary to document the addition of Option HO7.

DESCRIPTION

The Model 8412A Option HO7 provides digital readout capability. This allows interfacing with HP Model 5326B Timer/Counter/DVM. The frequency, phase, and magnitude of the parameter being measured by the network analyzer is then displayed digitally. No special procedures are needed when the rear panel REF and TEST outputs are not being used.

NOTE

When the rear-panel REF or TEST outputs are being used the load impedance should be greater than one megohm shunted by 25pf or less. Calibration of the 8412A Option HO7 must be done with rear-panel REF and TEST outputs loaded.

MANUAL CHANGES TO INCORPORATE OPTION

Page 5-4, Table 5-3; Page 5-12, Table 5-4; Page 5-20, Table 5-6; Page 5-25, Table 5-7:

Add to PROCEDURE OF STEP 1:

NOTE

Calibration of the 8412A Option HO7 must be done with the rear-panel REF and TEST outputs loaded. Load impedance should be greater than one megohm shunted by 25pf or less.

Page 6-10, Table 6-1:

Add C2 and C3 HP Part No. 0150-0084; C: FXD CER .1 uf +80 -20% 100VDCW.
Add W1 HP Part No. 08412-62001; CABLE ASSEMBLY: REF output (color coded gray, red, white, Includes J7).
Add W2 HP Part No. 08412-62002; CABLE ASSEMBLY: TEST output (Color coded gray, brown, green. Includes J8).

Page 6-11, Table 6-1:

Change part 19 to HP Part No. 08412-22019; Sub-panel: Rear.
Change part 20 to HP Part No. 08412-02102; Panel: Rear.
Change Part 28 to HP Part No. 08412-02007; Plate: Identification.

Page 7-9, Figure 7-10:

Change schematic diagram per following partial schematic:

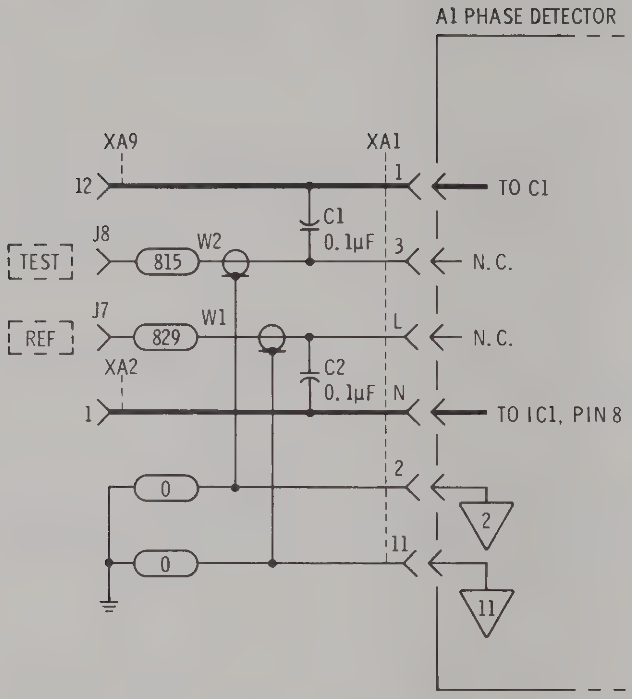


Figure II-1. Option HO7, Schematic Diagram

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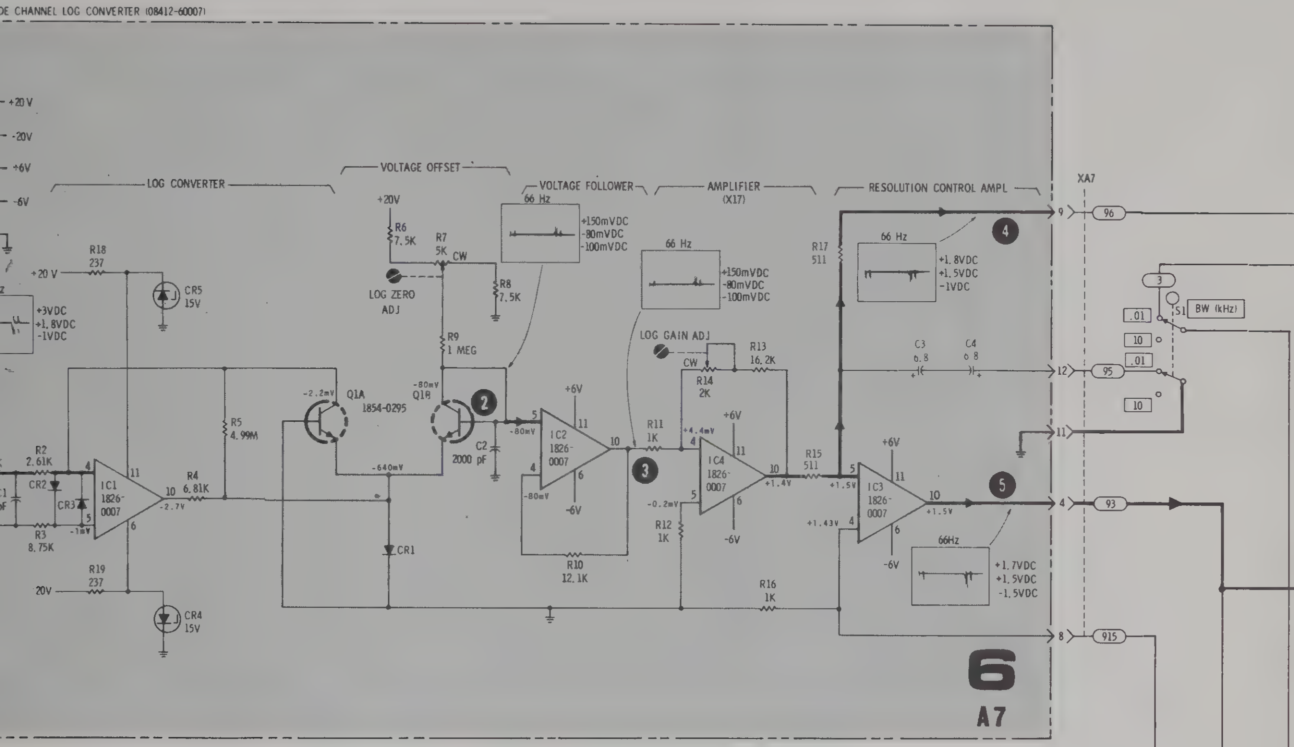
E 11-71

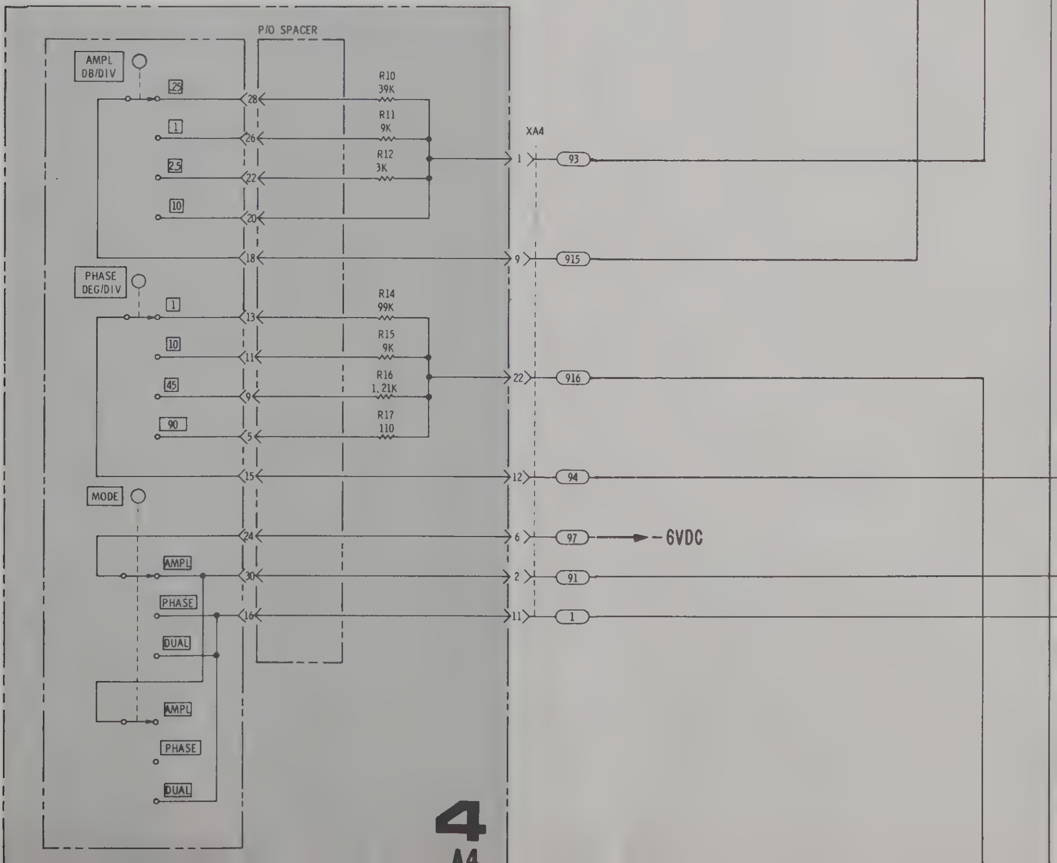
MODEL 8412A OVERALL SCHEMATIC DIAGRAM

HP PART NO. 08412-90022

A7 AMPLITUDE CHANNEL LOG CONVERTER



P/O A4 SWITCH ASSEMBLY



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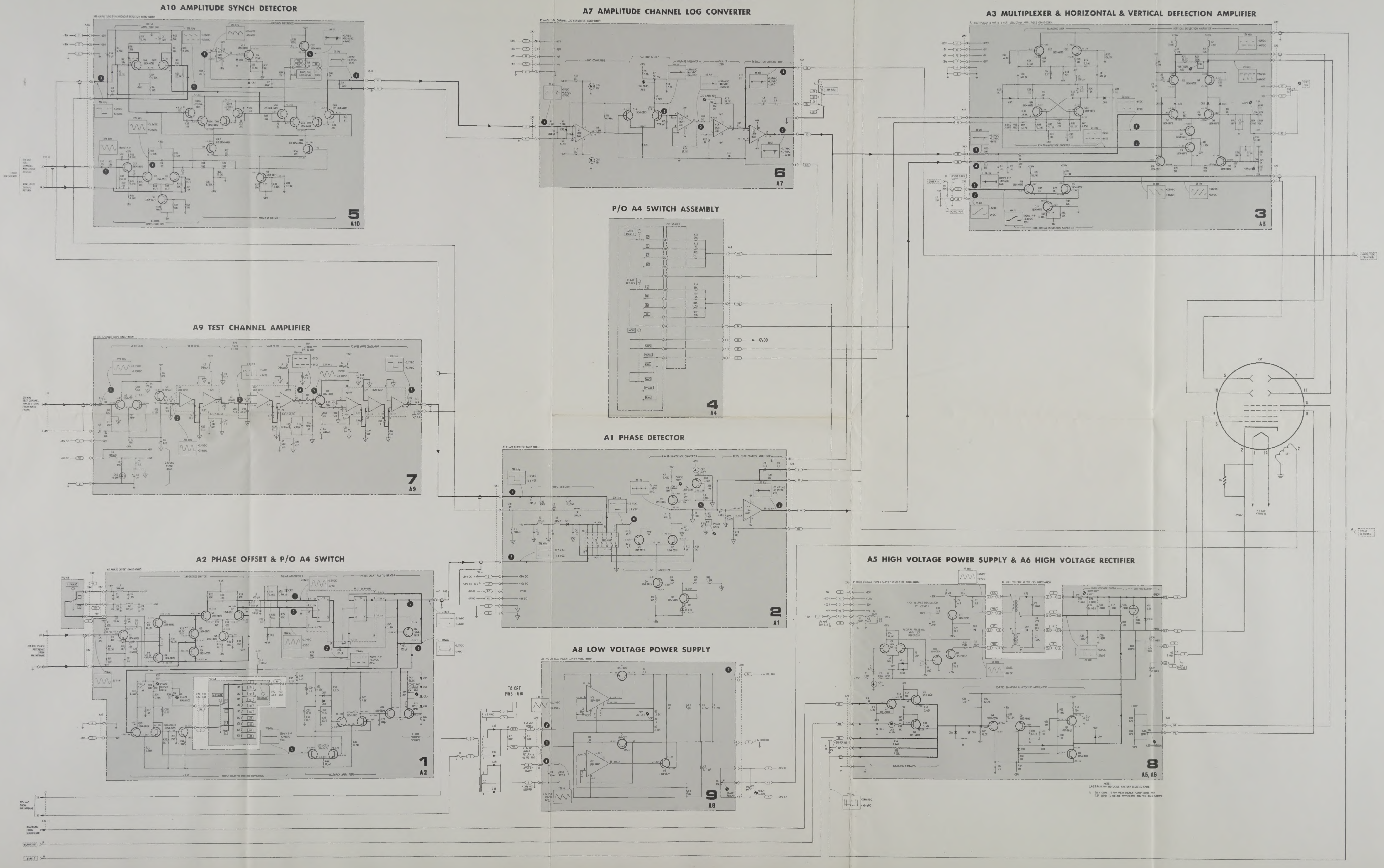


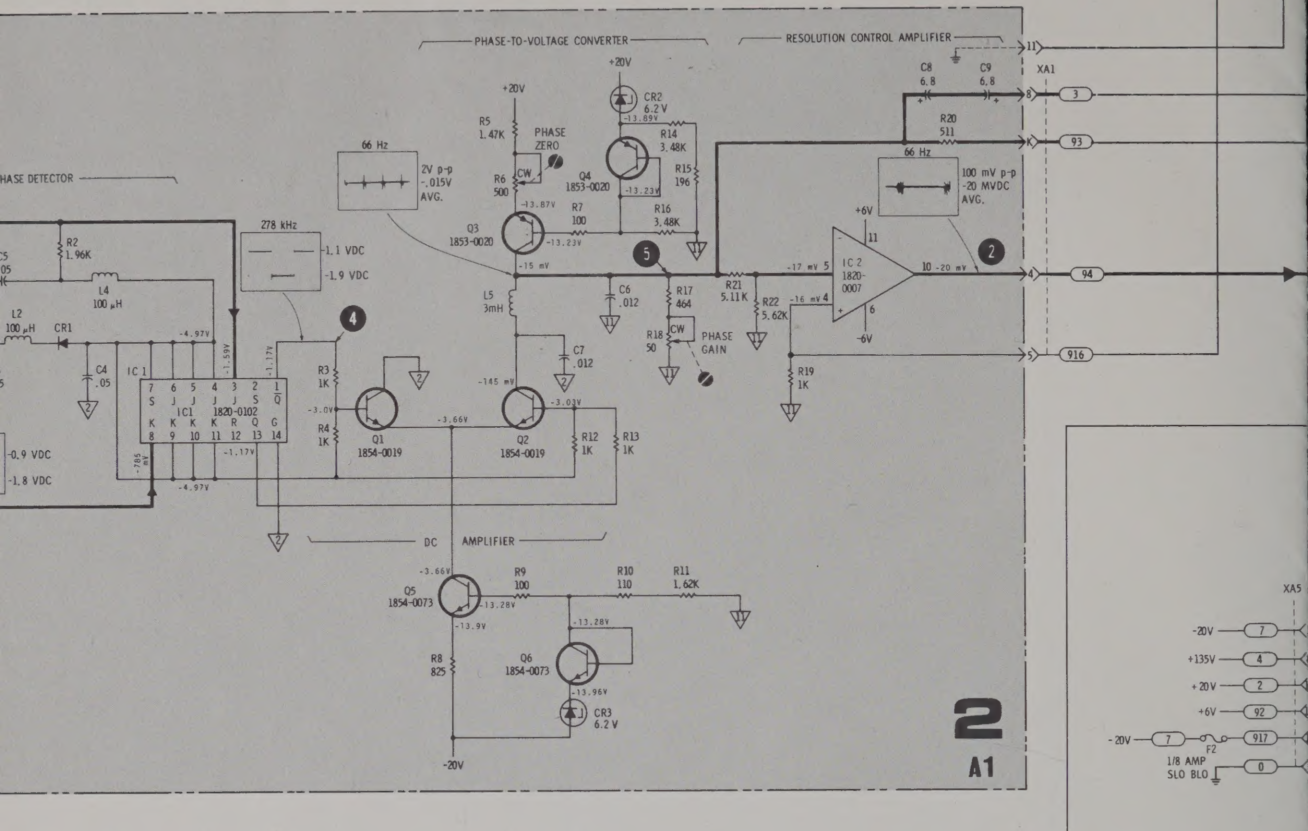
A10 AMPLITUDE SYNCH DETECTOR
5
A10
A7 AMPLITUDE CHANNEL LOG CONVERTER
6
A7
A3 MULTIPLEXER & HORIZONTAL & VERTICAL DEFLECTION AMPLIFIER
3
A3
P/O A4 SWITCH ASSEMBLY
4
A4
A9 TEST CHANNEL AMPLIFIER
7
A9
A1 PHASE DETECTOR
2
A1
A2 PHASE OFFSET & P/O A4 SWITCH
1
A2
A8 LOW VOLTAGE POWER SUPPLY
9
A8
A5 HIGH VOLTAGE POWER SUPPLY & A6 HIGH VOLTAGE RECTIFIER
8
A5, A6
TO CRT PINS 1 & 14
ASTIGMATISM

NOTES

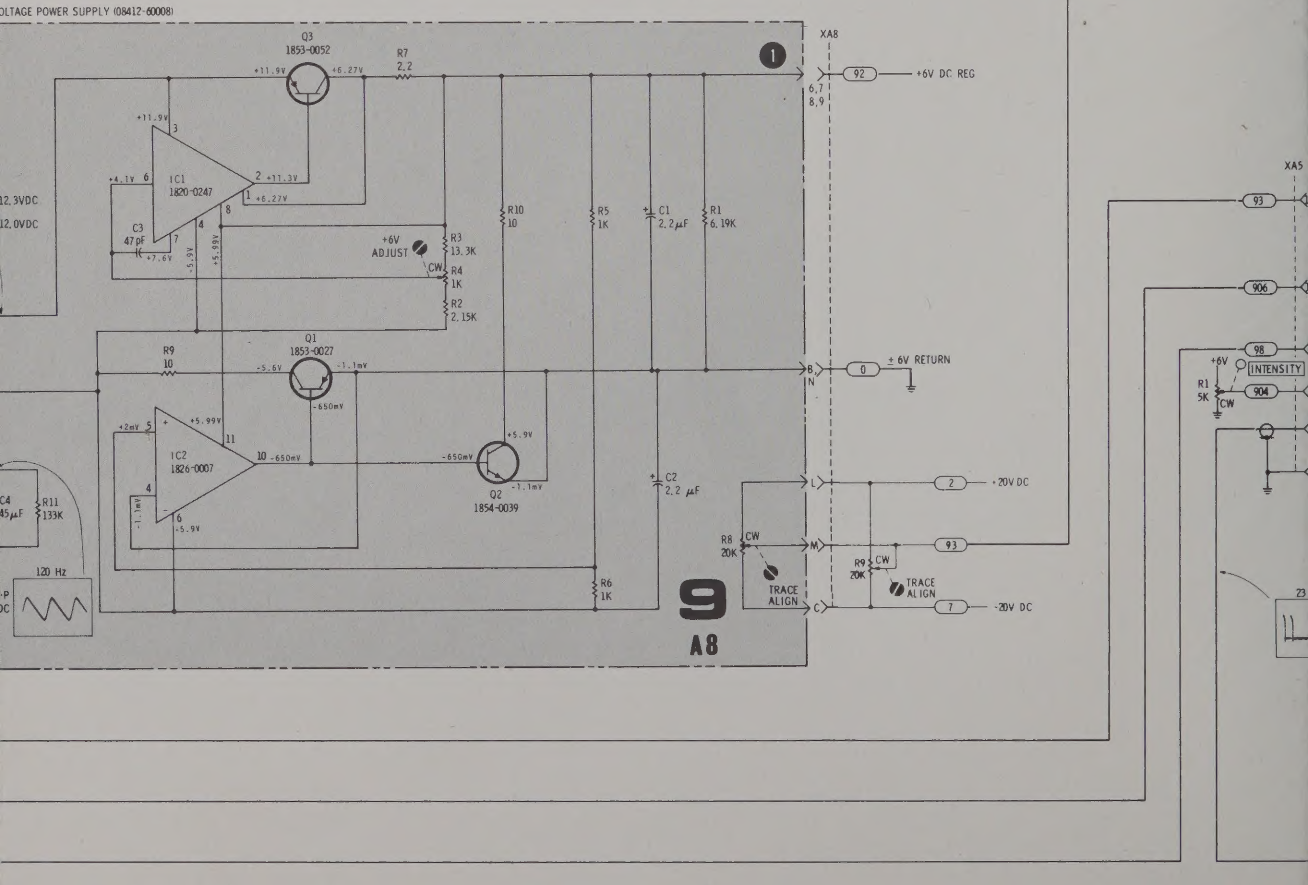
1. ASTERISK (*) INDICATES FACTORY SELECTED VALUE

2. SEE FIGURE 7-2 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

A1 PHASE DETECTOR



A8 LOW VOLTAGE POWER SUPPLY



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Printed in U.S.A.